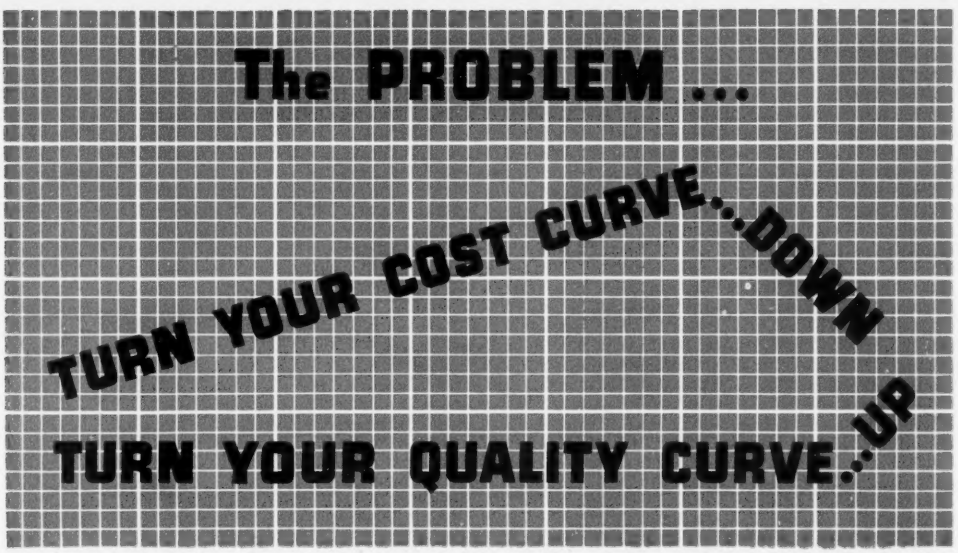
WIRE AND WIRE PRODUCTS

SEPTEMBER 1934



VAUGHN WIRE DRAWING MACHINERY

... An effective ANSWER*

This problem is always active. Both curves depend on two things—MACHINERY and MANAGEMENT. Our constant aim is to assist management in the selection of machinery best fitted to push these two curves in the right direction.

We can assist, too. Our experience in the wire machinery business extends over 63 years, and the Vaughn line includes efficient, modern equipment for every wire-drawing purpose. Whatever your problem, we shall welcome an opportunity of discussing it with you.

THE VAUGHN MACHINERY COMPANY

CUYAHOGA FALLS, OHIO

COMPLETE DRAWING EQUIPMENT . . . CONTINUOUS OR SINGLE-HOLE

For the Largest Bars . . . For the Smallest Wire . . . Ferrous, non-ferrous materials or their alloys

*TURN TO PAGES 274 - 275 THIS ISSUE

OFFICIAL PUBLICATION OF THE WIRE ASSOCIATION

SERVICE SERVICE SERVICE

LITERATURE

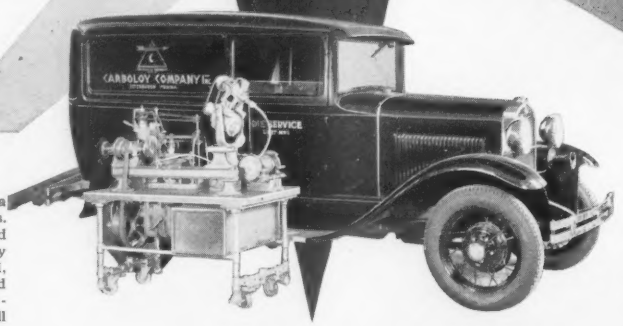
Up-to-the-minute literature of value to Carboloy Die Users is available without obligation. This literature includes:

1. Catalog and Handbook D-34 containing specifications and prices of standard Carboloy dies; Complete descriptions, illustrations and prices of recommended equipment and accessories for finishing and servicing Carboloy dies, and general instructions for recommended procedures.
2. Specifications for recommended holders to keep Carboloy dies cool and rigid.
3. Chart listing split gauges in decimal sizes.
4. Bearing Length Control Chart.

All available without obligation, upon request.

EQUIPMENT

Carboloy Company is prepared to recommend and supply machine equipment and accessories for finishing and servicing cemented carbide dies. Complete accessories and equipment are listed in our new Catalog D-34. Carboloy representatives will be glad to work with you in selecting the most economical and efficient equipment for your requirements.



DIRECT REPRESENTATIVES

Carboloy Company maintains a large staff of direct representatives. These men are strategically located within territories covered by offices at Chicago, Cleveland, Detroit, Newark, Pittsburgh, and Philadelphia. Immediate *personal* service is available in all important metal working centers.

NIB STOCK

Rapid overnight service is available, when necessary, on mounted nibs and dies in the more commonly used sizes, through the maintenance of nib stocks at Chicago, Detroit, Newark and Pittsburgh.

Visit booth No. 370, National Metal Exposition, New York City, October 1-5, 1934.

RECUTTING AND INSTRUCTION SERVICE

Of particular value to the user of Carboloy dies are the mobile-service-unit-at-large, pictured above, and transportable service equipment located in 4 key cities. This equipment can be brought into your plant for recutting service and, when desired, experienced operators will instruct your die men on the finishing and servicing of Carboloy dies.

CARBOLOY COMPANY, INC.

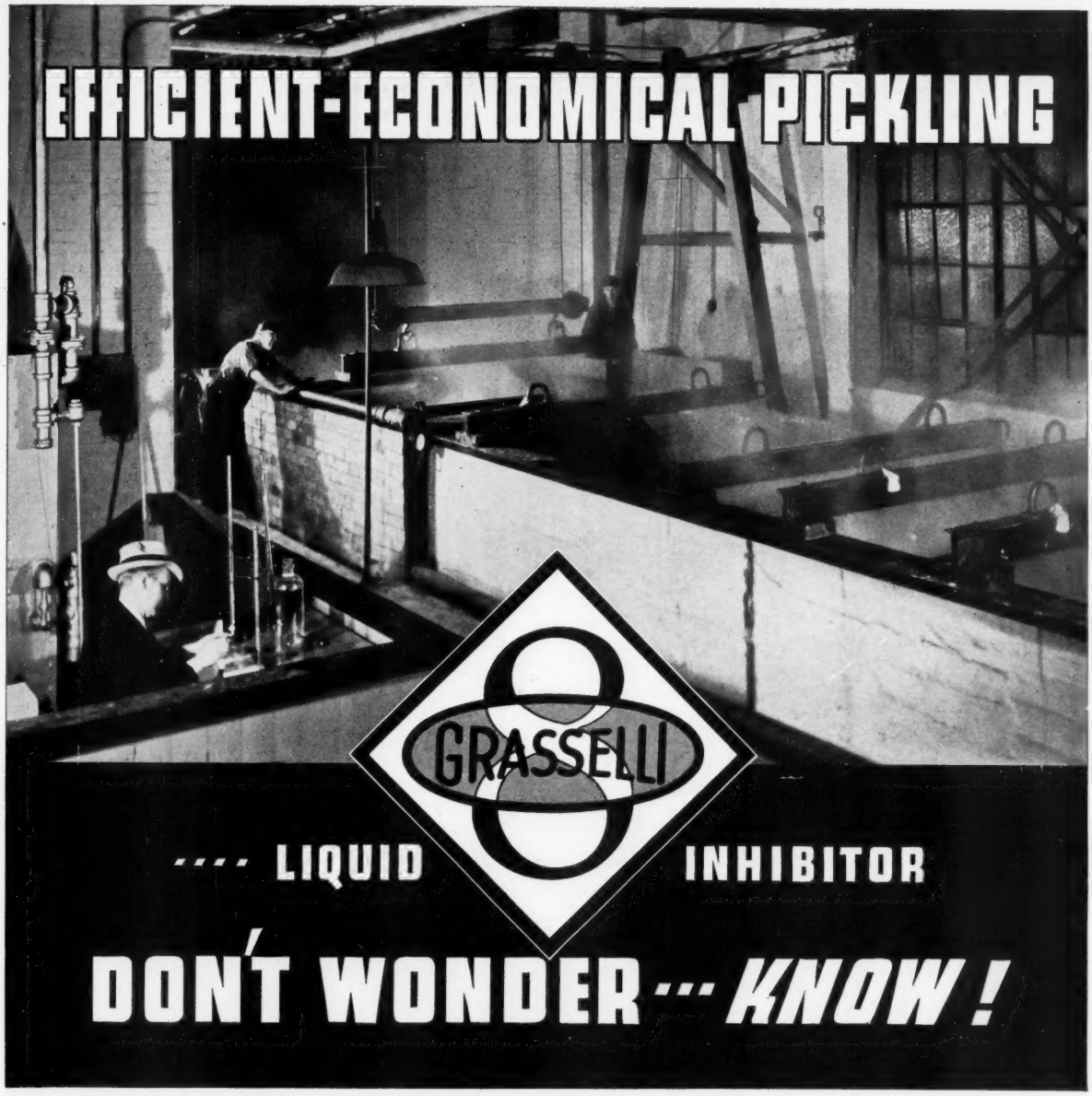
2481 E. Grand Blvd., Detroit, Michigan

Chicago Cleveland Newark Philadelphia Pittsburgh

"The Mark of CARBOLOY"

CARBOLOY SERVICE

"The Mark of CARBOLOY"



ARE you able to say that your pickling room is operating efficiently ...that your acid consumption and overall costs are at a minimum?

If not, consider the use of Grasselli 8 Liquid Inhibitor and in connection with its use, Grasselli Steel Service.

Each represents a valuable aid to your pickling operations. The cost of Grasselli 8 Liquid Inhibitor averages from 1c to 2c per ton of material pickled. THERE IS NO COST for the use of Grasselli Steel Service.

GRASSELLI STEEL SERVICE

Not a name but a complete all-around laboratory and plant pickling service ... maintained for the purpose of servicing our products and your problems. We ask you to make use of it.

Write for Interesting Booklet

THE GRASSELLI CHEMICAL CO.
INCORPORATED
Founded 1839 CLEVELAND, OHIO

GRASSELLI ... THE ANSWER TO YOUR PICKLING PROBLEM

How to Improve Quality at Low Cost . . . Use G-E Bell-type Electric Furnaces

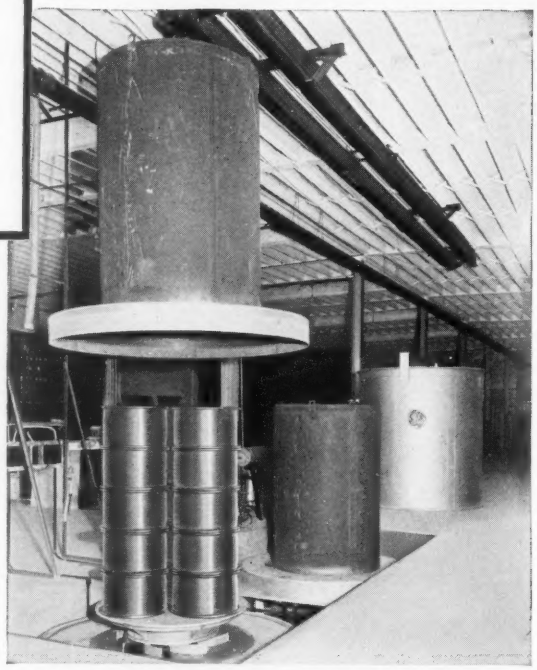
Your best sales appeal today is quality—your best assurance of high quality is electric heat-treatment

General Electric bell-type furnaces will bright anneal your product quickly, uniformly, and economically. They are designed for annealing steel, copper, or bronze wire, strip, or tubing in coils.

These G-E bell-type furnaces, equipped either with center heating elements or fans in the bases, today are making splendid performance records for satisfied users, and they will do the same for you. Outstanding advantages are:

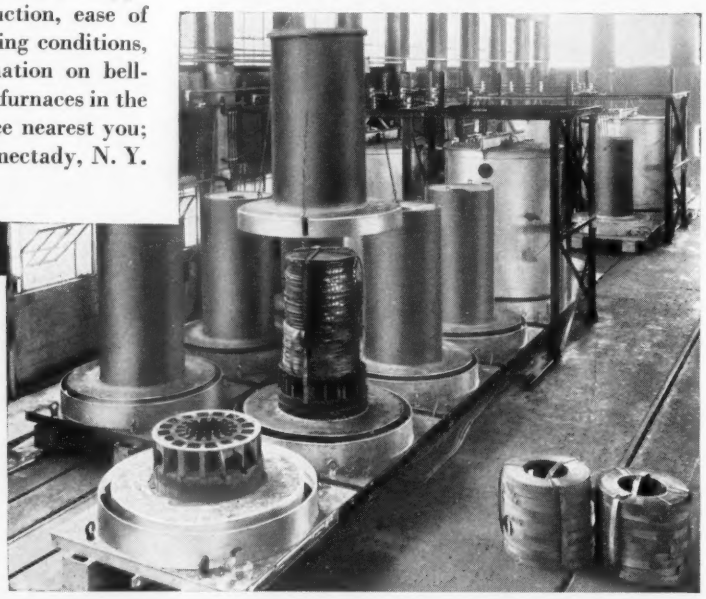
1. Low operating cost
2. Uniform anneal
3. Short time cycle
4. Good surface finish — eliminates pickling

You will find other advantages in using G-E bell-type furnaces, including flexibility of production, ease of loading, coolness and cleanness of working conditions, and low upkeep. For complete information on bell-type, bright-annealing furnaces or other furnaces in the *complete G-E line,* address the G-E office nearest you; or General Electric, Dept. 6A-201, Schenectady, N. Y.



ABOVE—G-E bell-type furnace with fans in the bases, for bright-annealing copper wire on reels

BELOW—Four G-E bell-type furnaces with center heating elements for bright-annealing coiled steel strip



COUPON

General Electric Company
Dept. 6 -201, Schenectady, N. Y.

Please send me a free copy of your new bulletin CONTROLLED-ATMOSPHERE ELECTRIC FURNACES, GEA-1924.

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GENERAL ELECTRIC

WIRE DRAWING DIES of VASCOLOY-RAMET

With VASCOLOY-RAMET wire drawing dies power consumption is lowered because of non-magnetic material and lowered coefficient of friction. Dies of VASCOLOY-RAMET may be made for drawing round, hexagon, octagon or special shapes.

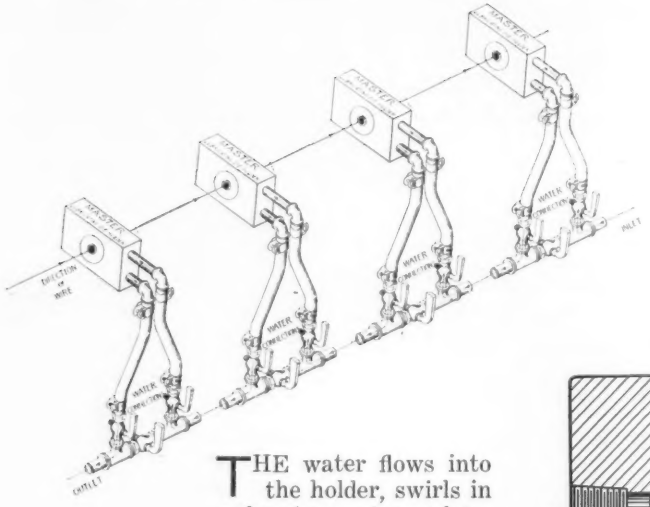
VANADIUM-ALLOYS STEEL CO., Pittsburgh, Pa.

(Note: Orders and inquiries should be directed to Vanadium-Alloys Steel Company . . . 1440 W. Randolph Street, Chicago, Illinois)

INCREASE YOUR DIE LIFE

The Master Die Holder
FOR DRY DRAWING

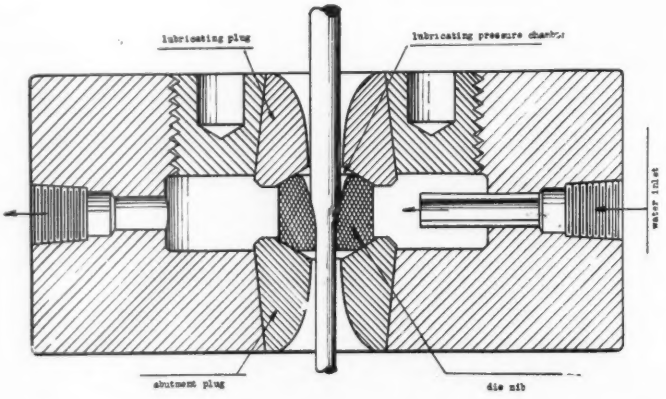
Double Your Production for the Same Cost of the Nib



THE water flows into the holder, swirls in a chamber and completely envelopes the carbide nib.

THE entire casing is eliminated.

THROUGH a unique design the nib is subjected to compression only.



A NEW METHOD FOR COOLING THE DIE NIB PROPER WHEREBY A LONGER LIFE AND ELIMINATION OF BREAKAGE IS EFFECTED.

FOR FULL DETAILS AND DEMONSTRATION ADDRESS

MASTER WIRE DIE CORPORATION

408 CONCORD AVENUE **NEW YORK, NEW YORK**

For 42 Years Industry Has Looked To IRONSIDES SPECIALISTS

for the answer to its toughest lubricating problems

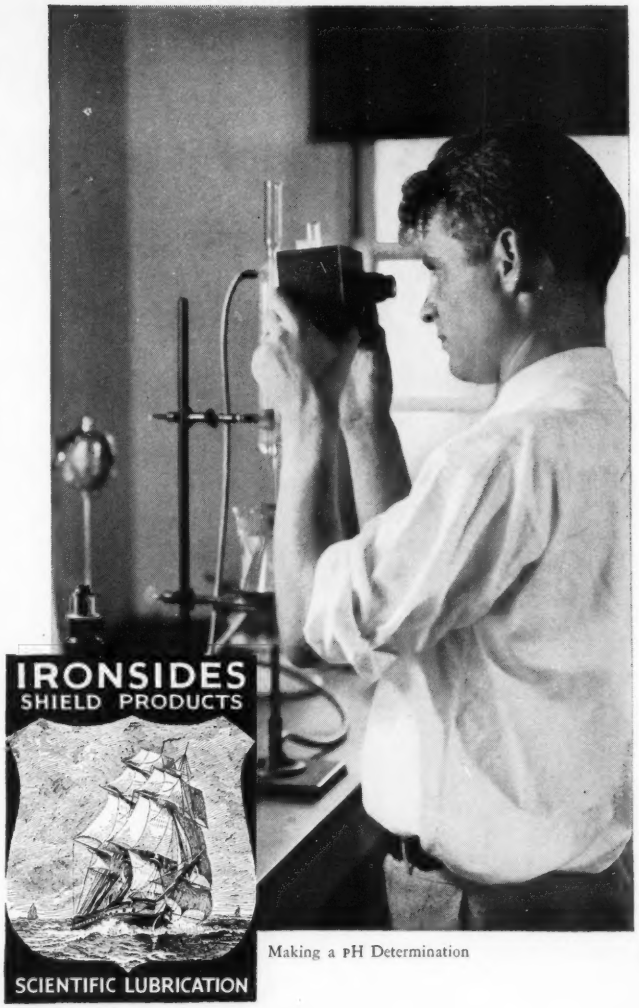
Specialists in scientific industrial lubrication since 1893, Ironsides engineers are called in more and more where a difficult lubricating problem has developed that requires expert attention and study.

The Ironsides Company maintains a staff of engineers, all lubrication specialists, whose services—together with the facilities of a modern, completely equipped laboratory—are available to serve you—ready to tackle the most difficult lubricating job.

This wide experience, plus constant practical and laboratory research in the development of scientific lubricants for new converting and manufacturing processes, has resulted in a complete line of highly efficient shield products for a diversity of industrial applications.

Among those developed for the steel and wire industry and of particular interest to the readers of this magazine are:

- Grade Y Gear Shield—for exposed gears
- Grade ZZZZ or TG Gear Shield—for encased gear drives
- Grade AR-6 Roll Neck Shield—Bulk type extreme pressure lubricant for manual application or pressure lubricating systems
- Grades 14 and 15S Roll Neck Shield—block type lubricants for roll necks
- Grade C-500 Wire Drawing Shield for drawing coarse copper and brass wire



Making a pH Determination

- Grade C-855 Wire Drawing Shield for drawing coarse and medium copper and brass wire
- Grade C-201 Wire Drawing Shield for drawing fine copper and brass wire
- Grade WD-4½ Wire Drawing Shield for bench block drafts
- Grade DP Wire Drawing Shield for rod dipping
- Grade C-450A Wire Cleaning Shield for water-sealed annealing furnaces
- Wire Rope Filler, for laying up cables

A letter to our offices, or a request of the Ironsides representative in your locality, will receive prompt attention.

• • •

Our representative will maintain headquarters at the Hotel New Yorker during the Wire Association Convention. Appointments can be made thru the Convention Headquarters Office of the Wire Association.

THE IRONSIDES COMPANY

Scientific Lubrication

COLUMBUS • OHIO • USA

UPRIGHT CONE

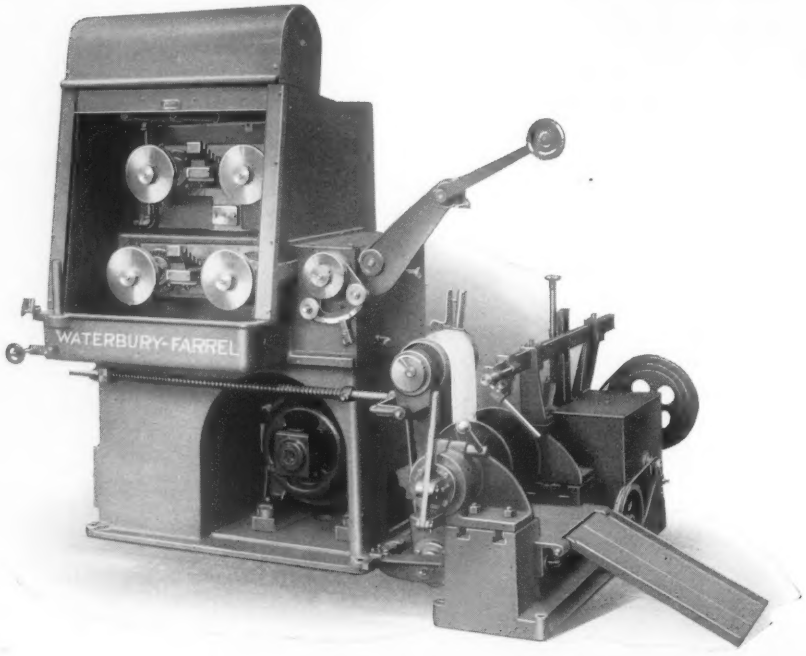
WIRE DRAWING MACHINES

DRAWING SPEEDS UP TO 6000 FEET PER MINUTE

FOUR SIZES---Max. Start No. 6. Min. Finish No. 44 B. & S.

PATENTED

Built to Finish On Spools -- In Coils -- Or As Combination Machines



No. 1 MACHINE WITH 100 POUND SPOOLER

Max. Start No. 14 B. & S. Operating 16 or less dies.

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WIRE ASSOCIATION EXHIBITION
PORT AUTHORITY BLDG.
NEW YORK, N. Y.
OCTOBER 1, 2, 3, 4, 5, 1934

WATERBURY FARREL FOUNDRY & MACHINE COMPANY

HOME OFFICE AND WORKS - WATERBURY, CONNECTICUT

BRANCH SALES OFFICES IN CHICAGO, CLEVELAND AND PHILADELPHIA

FOREIGN AGENCIES: GEO H. ALEXANDER MACHINERY LTD., BIRMINGHAM, ENGLAND
ETAB B. GATTEGNO, PARIS, FRANCE. KABLE INDUSTRIAL ENGINEERING CO., SHANGHAI, CHINA

FARREL-BIRMINGHAM COMPANY, INC.

Successors to Farrel Foundry & Machine Co. (Est. 1848) and Birmingham Iron Foundry (Est. 1836)

38 Main Street, Ansonia, Conn.

Plants at Ansonia and Derby, Conn., Buffalo, N. Y.

SALES OFFICES AND REPRESENTATIVES

344 Vulcan Street, Buffalo, N. Y.
2710 First Central Trust Building, Akron, Ohio
1059 First National Bank Building, Chicago, Ill.
79 Wall Street, New York, N. Y.

D. A. Comes, 210 Poplar Avenue, Hackensack, N. J.
J. P. Flippen, 1704 Oliver Building, Pittsburgh, Pa.
George L. Hurst, 785 Market Street, San Francisco, Calif.
H. F. Parkerton, 1506 Santa Fe Ave., Los Angeles, Calif.

ROLLING MILL MACHINERY:

Rolling Mills — For non-ferrous metals, foils and cold strip steel. Complete rod mills from furnace to coilers.

Rolls—All sizes for various purposes. Alloy iron, chilled iron, dry sand, grey iron, steel.

Blockers and Coilers.

Roll Grinding Machines.
Roll Calipers.
Presses—Hydraulic and Mechanical.
Cinder Grinders.
Cut Double Helical Gears and Mill Pinions.
Gear Drives.
Flexible Couplings.
Blast Gates.

COPPER ROD MILLS:

Farrel-Birmingham Copper Rod Mills are designed to roll a diversified product of high quality at low cost. Low productive cost means high speed operation with a small operating force, low power consumption and minimum scrap. Automatic handling equipment reduces labor; maximum power saving is obtained by anti-friction bearings throughout; and high quality with minimum scrap is assured by proper design.

Fig. 1—20″x60″ three-high breaking-down and roughing stands of copper rod mill, showing feed table and oval repeater.

Farrel-Birmingham engineers will design, supply and install complete copper rod mills from furnace to coilers for any required output. Full details about the benefits derived from the installation of modern, low cost Farrel-Birmingham equipment will be sent upon request.

Figures 1 to 4 inclusive are views of a complete eleven-stand mill with a capacity of 150 tons of ¼″ round copper rod per ten-hour day, or 200 tons of $\frac{5}{16}$″ and ⅜″ rods. The mill consists of a 20″x60″ three-high breaking-down stand, a 20″x60″ three-high roughing stand and an intermediate and finishing train of nine stands with rolls of 20″ face graded from 11½″ to 14″ in diameter.

Fig. 2—Intermediate and finishing train of copper rod mill. Note repeaters and tubes to coilers.

All of the mills are equipped with anti-friction bearings on the rolls and pinion units, greatly reducing friction and power consumption. Farrel-Sykes cut double helical, continuous tooth mill pinions, with universal joints connecting the rolls and pinions, transmit power to the rolls smoothly, silently, efficiently.

The breaking-down and roughing mills are completely equipped with feeding tables, stop gate, turning guides and repeaters, placing complete control of all passes and operations, from the loading of the heating furnace to the first pass in the finishing train, in the hands of one operator stationed in the pulpit. Automatic looping repeaters are also provided for two passes in the intermediate train. The automatic feeding features make it possible to operate the complete mill at increased capacity with a considerable saving in labor.

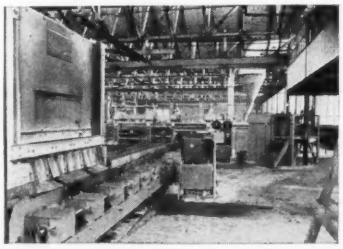


Fig. 3—Roller feed table from furnace to breaking-down mill. Control pulpit is shown at right center.

From the last mill the finished rod is delivered through tubes to the coilers. Three coilers are provided and the delivery tubes are so arranged that any grooves which may be set up in the mill can deliver to any one of the three coilers. The coilers are designed to coil hot copper rod up to ½″ diameter at delivery speeds up to 1600 feet per minute.

The coilers and the conveyor, onto which the coilers discharge, are controlled at a desk located in front of the coilers. The operator at this desk controls the starting and stopping of the coilers and of the conveyor, and the alignment of any particular groove in the finishing mill with any particular coiler.

Fig. 4—Three copper rod coilers with conveyor to cooling tank. Control desk is shown at the left.

HEAVY DUTY ROLL GRINDERS:

Farrel Heavy Duty Roll Grinders are widely used in metal rolling plants for grinding all types of metal working rolls. They are designed for better, faster and cheaper grinding to the extreme limits of accuracy required by modern industry.

They are made in five standard sizes to handle rolls up to maximum diameters of 28″, 36″, 44″, 52″ and 60″, and in any lengths from 8′0″ to 26′0″ between centers. Figure 5 is a general front view of a 60″x20′0″ machine.

Design features: Individual motor drive for each unit with centralized control at operator's station. Crowning device produces mathematically correct crown or concavity — very easily and quickly set. Improved spindle and wheel head design. Carriage driven by reversing motor though cut double helical gears and worm and rack. Inverted V-type ways, flood lubricated. Dead centers in both headstock and footstock. Heavy, rugged construction imparts stability. Combination of all features assures high quality of work with maximum production.

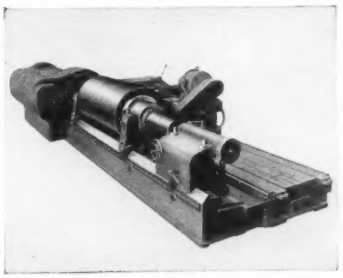


Fig. 5—60″x20′0″ Farrel heavy duty roll grinder.

FARREL-SYKES GEARS AND GEAR UNITS:

Spur, helical and herringbone gears of any material suitable for gears: ¼″ to 22′0″ in diameter; ¼″ to 60″ face; 24 D.P. to ½ D.P. Produced by gear specialists — accurately generated — smoothly finished. Efficient, quiet, durable.

Herringbone Gear Units in single, double and triple reductions. Any ratio from 1/1 to 300/1. Any horsepower from 1 to 10,000. Meet all requirements for uniform, silent and positive transmission of power.

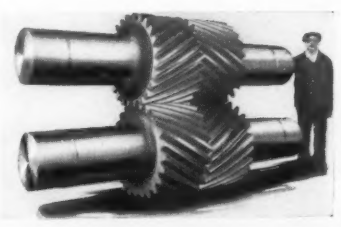
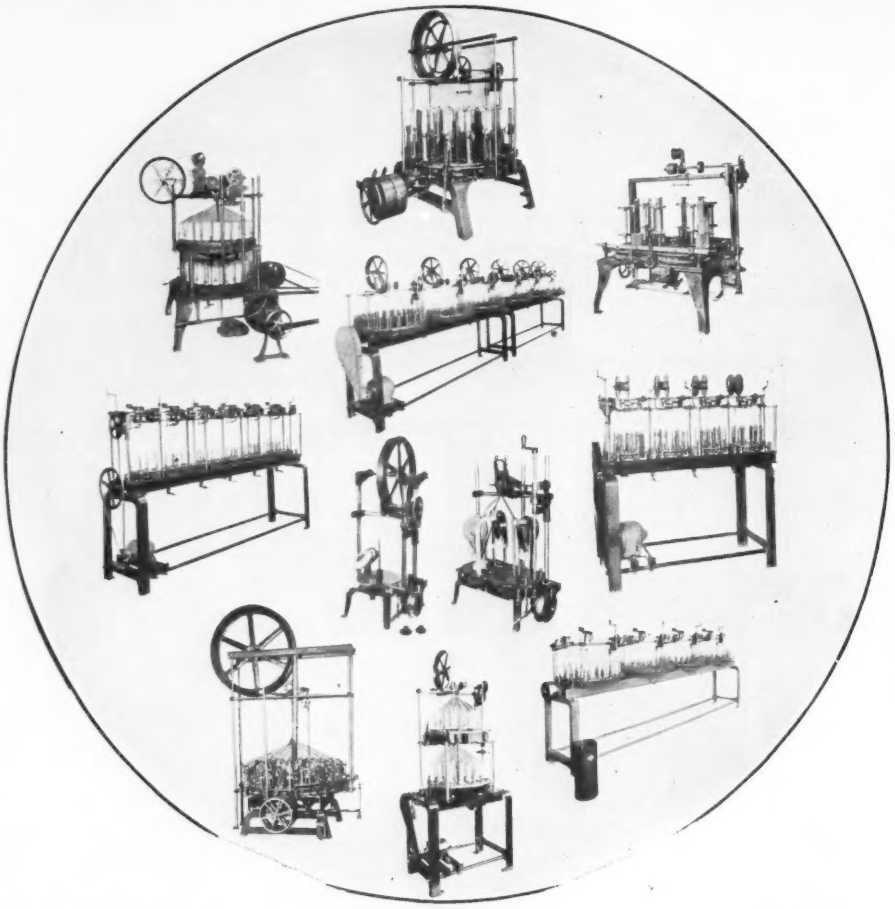


Fig. 6—Farrel-Sykes continuous tooth herringbone mill pinions.



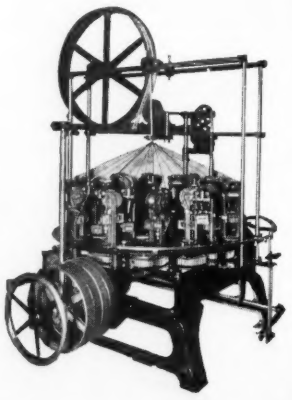
Braiders for Covering Wire & Cable

Asbestos	Braids
Copper	"
Cotton	"
Jute	"
Hemp	"
Paper	"
Rayon	"
Steel Wire	"

Multiple Head Wire Covering Braiders complete with built in reel stands, traverse motion and windup mechanism, made in sizes having 16, 20 and 24 carriers. Suitable for covering wire with asbestos, cotton or rayon braids. Exceptionally good production running at speeds as high as 280 horn gear revolutions per minute.

Single Head Cable Covering Braiders made in single or double deck type, direct motor or belt drive. Two sizes: No. 1 yarn packages 2½x6; No. 2 yarn package 3½x7. Made with 16, 20, 24, 32 and 48 carriers.

Single Head Wire Braiders made with horizontal bobbin carriers. Size of bobbin 4¼x3. Horn gear diameter 7.33; 36" or 48" capstan. For putting aluminum, copper or steel braids on cables.



WRITE US ABOUT OUR NEW WIRE COVERING PROCESS

FIDELITY MACHINE COMPANY

PHILADELPHIA, PA.

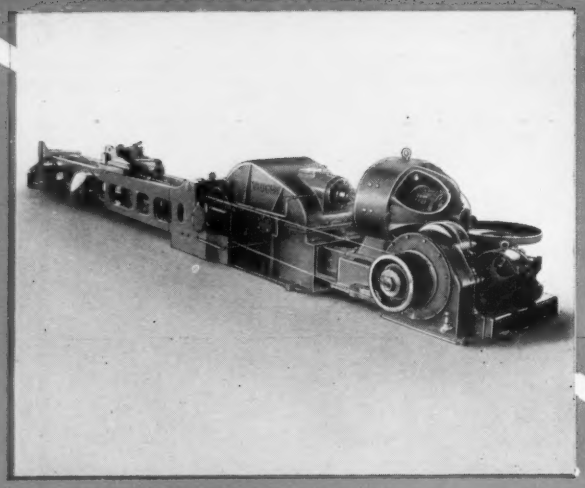
We Extend Greetings to the

Members of the

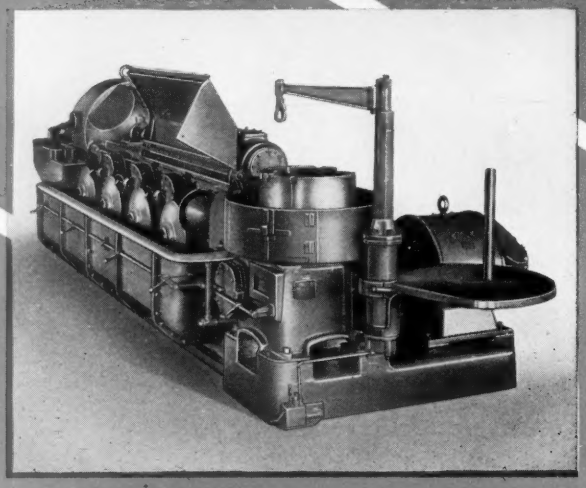
Wire Association

Hubbard Spool Company

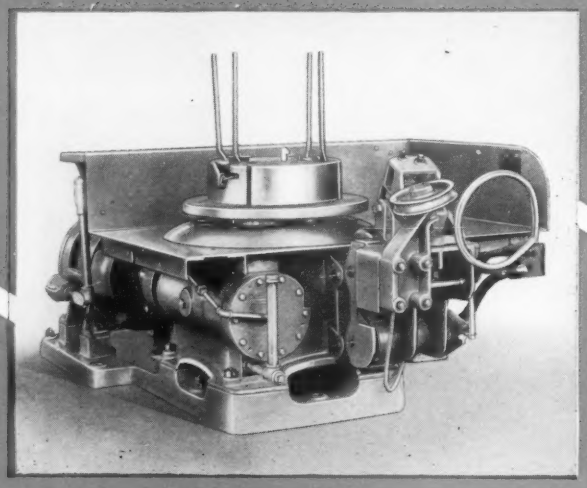
1622 Carroll Ave., Chicago



DRAW BENCHES



TANDEM MACHINES



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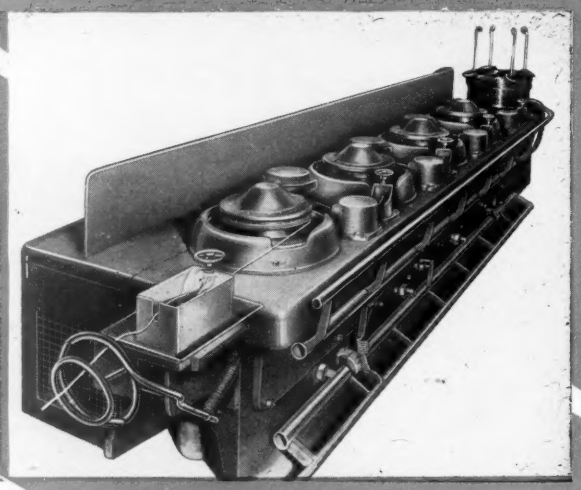

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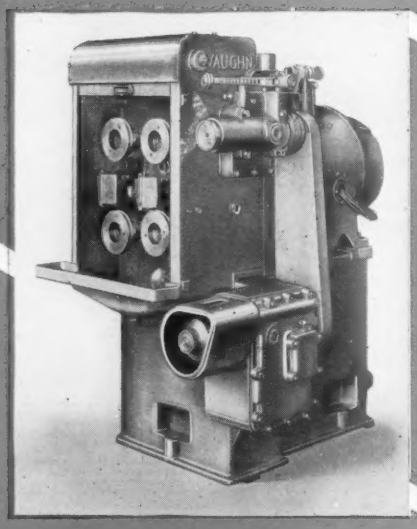
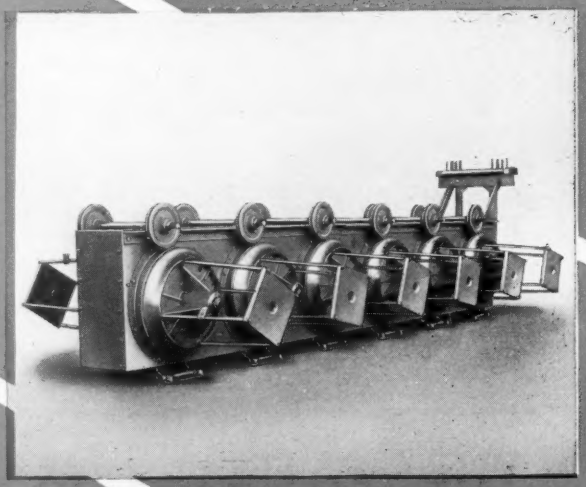


CONE MACHINES



TAKE-UP FRAMES

VAUGHN WIRE DRAWING MACHINERY

Complete Equipment for Steel, Copper or Alloys

Vaughn Wire Drawing Equipment,—described below,—includes a machine for every wire drawing purpose, irrespective of the metal to be drafted or the size of the product . . . compact, speedy, efficient equipment that meets every demand of wire-mill management.

FOR WET OR DRY DRAWING

DRAW BENCHES

For bars or tubes, any size, any length, any capacity . . . improved features in design of drive, chain, carriage return and unloading.

MOTOBLOC

Six sizes for drawing in coils 1" and smaller with a wide variety of adjustable speed ranges. Single spindle or turn table, single or double deck, air cooled.

MOTOBLOX

A line of continuous machines:

(1) H. R. Rod for drawing No. 11 to No. 16, —3, 4, 5 or more drafts.

(2) H. I. Intermediate for drawing No. 17 to No. 25.

(3) H. F. Fine for drawing No. 26 to No. 36.

TANDEM MACHINES

(Normally Wet)

Usually for copper and their alloys from 5/8" and smaller,—any required number of drafts, for both spools and coils.

CONE MACHINES

(Normally Wet)

Usually for copper and their alloys. Several sizes for drawing from rod to fine wire, for both spools and coils.

TAKE-UP FRAMES

For Patenting . . . Galvanizing . . . or Tinning.

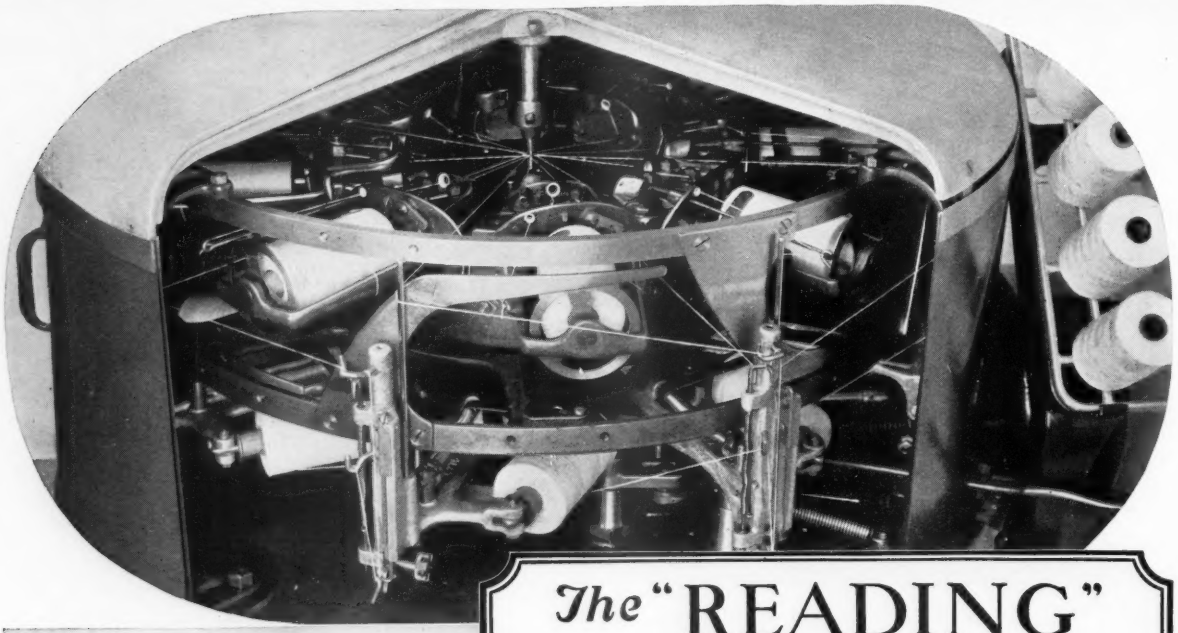
In addition to the primary equipment described above, we also manufacture Pointers . . . Die Stringers . . . Spoolers . . . Trucks . . . Scrap Bundlers . . . and other incidental accessory equipment.

THE VAUGHN MACHINERY COMPANY

CUYAHOGA FALLS, OHIO

"Vaughn Wire Drawing Equipment Is the Result of 63 Years of Specialization and Leadership"

The "READING" Rotary Braider will be shown publicly for the first time at the National Metal Exposition, Commerce Hall, 111 Eighth Avenue, New York—Oct. 1st to 5th, (Booth 405)



The "READING" Rotary Braider

The "READING" Rotary Braider is built with sixteen carriers and can be operated as a plain or diamond pattern braider by changing the yarn deflectors.

The upper set of carriers runs against ball-bearings. The lower set is carried on a table running on a ball-bearing spindle.

The use of these ball-bearings practically eliminates all friction in the carriers. And because the carriers operate in a horizontal plane, carrier friction does not increase as the speed of the machine is increased.

• • •

The "READING" Machine is equipped with a fully automatic mechanical stop-motion so designed that, if a braiding thread breaks, the machine stops before the broken end of yarn gets to the braiding point.

If an end of yarn becomes either slack or tight the machine stops automatically. This stop motion is so sensitive that when an end of yarn becomes tight the machine stops automatically before the yarn breaks.

In the "READING" Machine the yarn packages are carried on tube holders which revolve on ball-bearings. Friction on the yarn is thus reduced to a minimum.

This makes it possible to use ordinary braiding yarns and does away with the necessity of having to use higher priced special yarn.

• • •

When used for braiding over insulated wires, a stop-motion is provided which stops the machine automatically when the end of the wire core is reached.

• • •

The head is fully enclosed for protection against accidents and all gears outside of the head are provided with guards.

• • •

The takeup reel fixture is a separate self-contained unit which is driven from the braider. It starts and stops with the braider.

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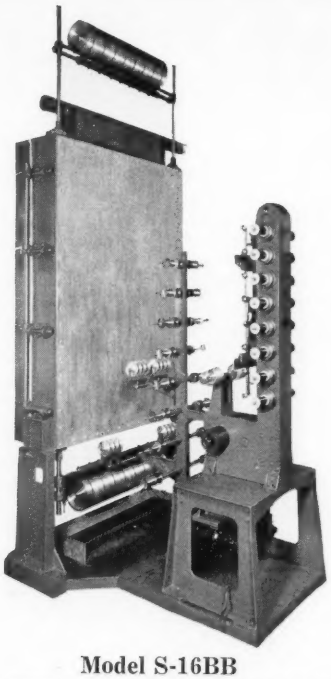
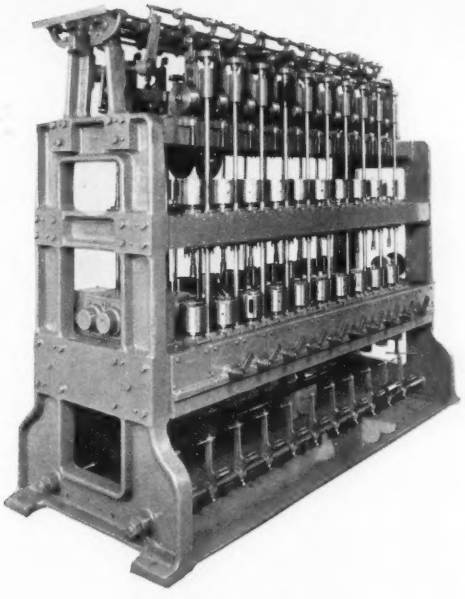


Model S-16BB
FINE WIRE ENAMELING MACHINE,
Ball-Bearing and Motor Drive.



Model OD-20BB
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High Speed, Ball-bearing, Motor Drive.

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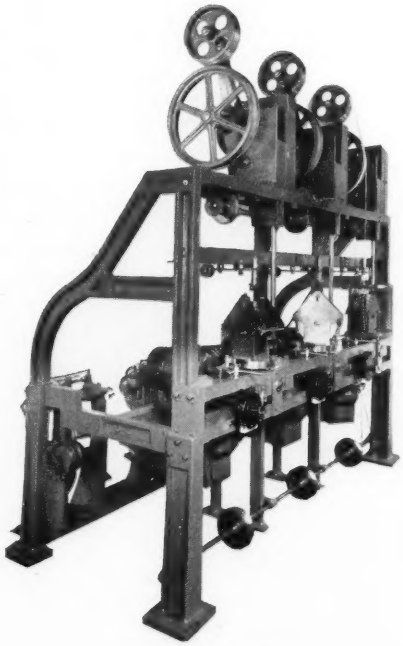
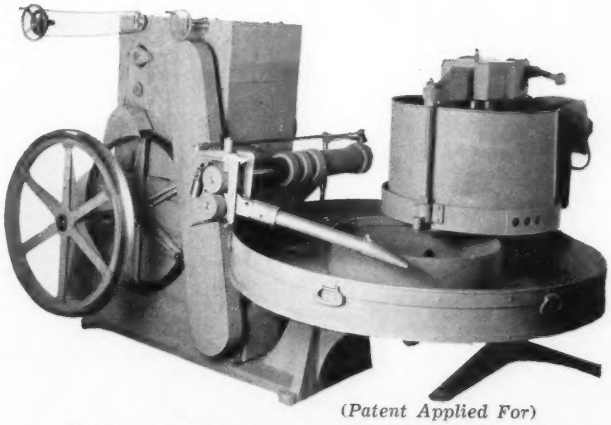


Model 3D-3T BB
WIRE TAPING MACHINE.
Individual Unit Motor Driven,
Ball-Bearing and Electric Braking.



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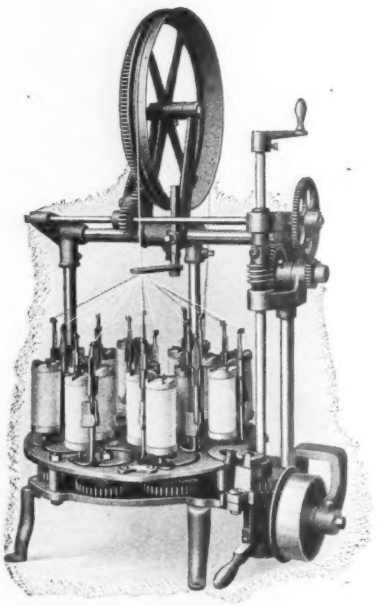

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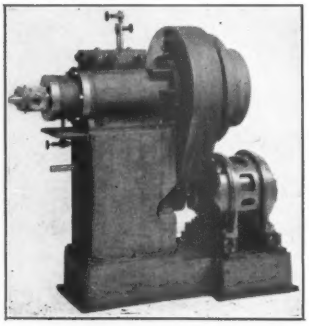

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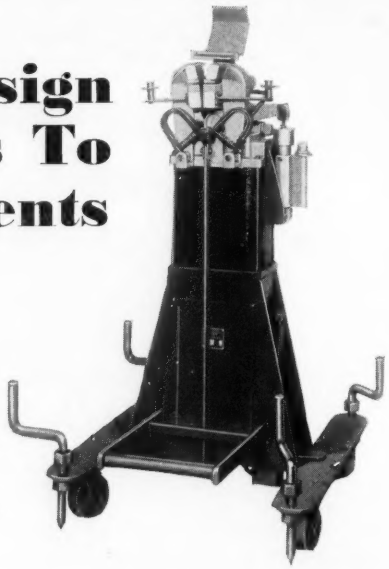

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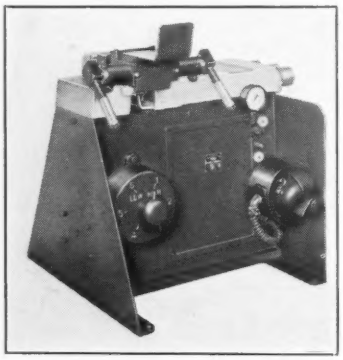

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WIRE AND WIRE PRODUCTS

A monthly publication devoted to the production of Wire, Rod and Strip Wire Products and Insulated Wire and Cable.

DRAWING—ROLLING—EXTRUDING—FORMING—FABRICATING

Vol. 9 September 1934 No. 9

Designated as

Official Publication By The Wire Association

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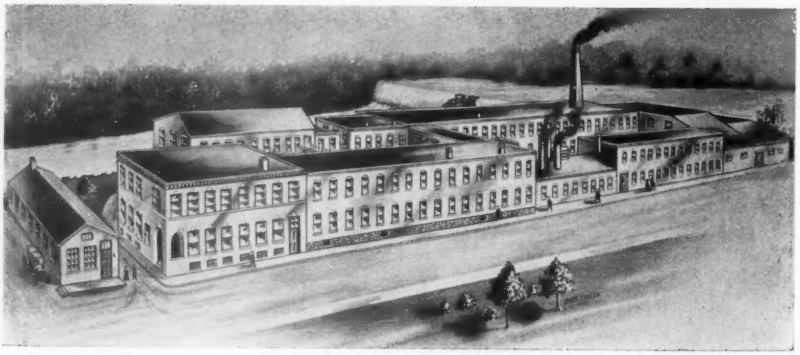

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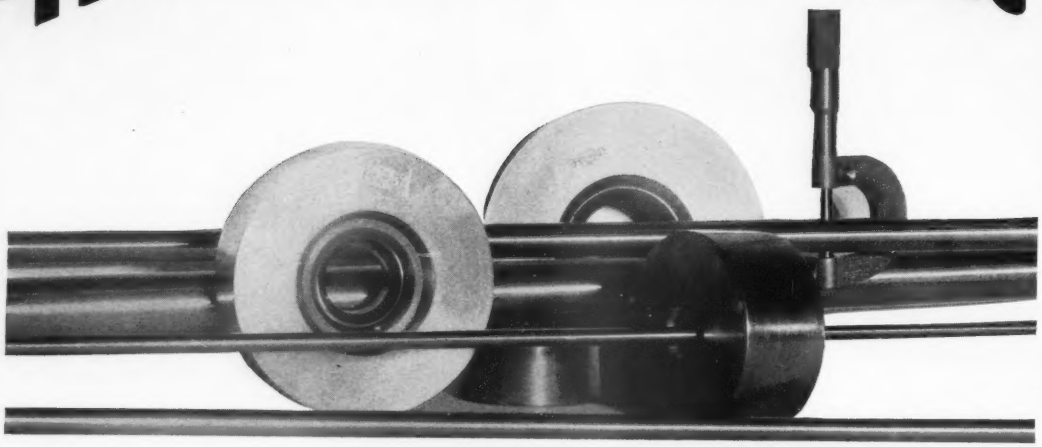

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A monthly publication devoted to the production of Wire, Rod and Strip.
Wire Products and Insulated Wire and Cable.
DRAWING --- ROLLING --- EXTRUDING --- FORMING --- FABRICATING

Vol. 9 September 1934 No. 9

Cold Drawn Steel Spring Wire

By Edward J. P. Fisher,
Physical Metallurgist, Keystone Steel & Wire Company, Peoria, Ill.

A research paper prepared for The Wire Association in which is shown the application of certain scientific principles to the art of making quality cold drawn high carbon steel spring wire.

THERE are so many varieties of springs and an even greater number of applications in this day that anyone, given only a glimpse of these hidden works of art, might easily conclude that this is an "hel(l)ical" world after all. Fortunately, we are to be spared such confusion by limiting our discussion to one simple, valuable and competent material of construction, namely,—'cold drawn high carbon steel spring wire.'

✦ ✦ ✦

Requirements For Spring Wire

IN general, a material suitable for use in spring construction must have uniform hardness, elasticity, plasticity, resilience and endurance under repeated stress. The material used will obviously be determined by its cost and the physical and chemical qualities required. For example, bronze might be used to gain corrosion resistance at a sacrifice in hardness or torsional strength. Or, stainless steel might be used at greater cost with higher strength. There are, however, so many applications for cold drawn high carbon steel spring wire that it has developed into a major product in both the wire and the spring industry. Hence the justification for the limited scope of this paper.

E. J. P. FISHER

Born of American parents in Berlin, Germany, in December, 1900. Received B. S. degree in chemistry, Worcester Polytechnic Institute, in 1921. Pursued post-graduate studies in Metallurgy at the School of Mines, Columbia University in 1921. From 1922 to 1929 his early metallurgical career was quite varied and included connections with General Electric Company, R. Wallace and Sons Manufacturing Company, Carpenter Steel Company and the Diamond Chain and Manufacturing Company. In November, 1929 began his present connection as Physical Metallurgist with Keystone Steel and Wire Company and is in charge of the Metallographic and Physical Testing Departments and directs high carbon wire research and development especially. Member of the American Society for Metals, the American Institute of Mining and Metallurgical Engineers, the American Society for Testing Materials, the Wire Association, the American Petroleum Institute and the Peoria Academy of Science, of which he is the present Secretary.

✦ ✦ ✦

Origins of Quality Spring Wire

WHILE omission of the history of the manufacture and use of cold drawn high carbon spring wire is excusable, we should consider those sources of quality which definitely affect the character of the finished wire. Thus, we will recount the various stages in the evolution of the spring steel rod from the open hearth charge with special reference to quality factors.

✦ ✦ ✦

MOST of the hard drawn steel spring wire used is produced from basic open hearth steel, so we will further limit this discussion. The quality of our wire must have its origin in the open hearth melting practice. A selected charge of pig and heavy and medium scrap is necessary. Melting down and finishing of the heat is both an art and a science. Of this we have been learning more with time. Temperature, slag condition, iron

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oxide content of the bath, speed of tapping and teeming, deoxidizing time and agents, mold size and temperature are the chief factors (and many others) in the making of quality spring steel ingots. Primarily, of course, the ingot must have the proper constitution, namely, by usage:

% Carbon	% Manganese
.50—.70	.90—1.20
% Phosphorus	**% Sulphur**
.040 Max.	**.045 Max.**

✦ ✦ ✦

EXCESSIVE segregation of carbon, manganese, phosphorus and other constituents in the steel ingot is without a doubt one of the main causes of poor spring wire quality. Increasing the speed of freezing of the steel in the **mold** and the use of good clay hot tops are two means of preventing excess segregation in the body of an ingot. Ingot size should be as small as economically possible. Some work is being done now on the use of copper stools for molds which allow more rapid solidification.

Soaking Pit Practice May Affect Quality

SOAKING pit practice in the blooming mill may be the source of high or low quality. Excessive temperature, oxidizing atmosphere, "burning" of the ingot surface, spalling or checking of the ingot surface in the pits are to be carefully avoided. Sufficient time must be taken to obtain proper equalization of internal and external temperatures of the ingot. A good ingot may be ruined in the soaking pit or its high quality may be preserved to the rolls. Good roll design and pass arrangement will enable the roller to reduce a sound hot ingot to a finished billet, free from excessive surface defects and having an internal structure free from "ingotism" or dendritic crystallization originally formed in the freezing of the ingot. In actual practice, billets are thoroughly inspected for surface and internal defects and so culled before transfer to the rod mill.

✦ ✦ ✦

Rod Mill Practices

IN the rod mill, the sound billets are first reheated to rolling temperature in the billet reheating furnace. Here again it is necessary for maintenance of quality, to adhere to all the best rules of quality heat treatment. Otherwise, a good spring steel billet may become delinquent internally and externally, chiefly the latter. The finished rods should be inspected for surface condition and the ends trimmed back to eliminate fins or shoulders frequently obtained in high speed finishing mills. To facilitate subsequent cold drawing, of the green (as rolled) rod, little or no water should be used in the reel pipes, otherwise quench hardening would result. Thus, a heavy scale will result during cooling of the rods in the air from a finishing temperature of approximately 1800°-1900°F.

Microstructures of 1¾" sq. Billet—.61% C and 1.11% Mn.

Longitudinal Sections

FIG. 1. AS POLISHED x200

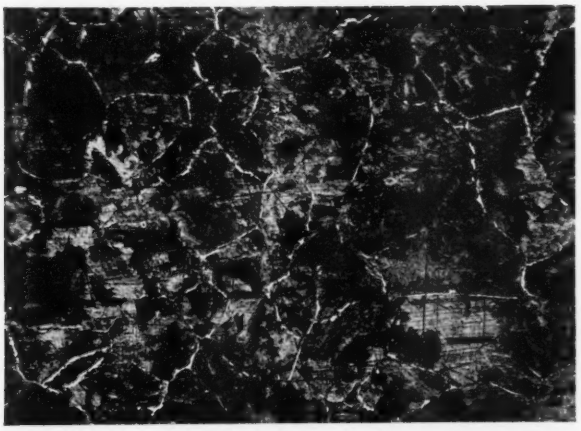

FIG. 2. ETCHED: 2% NITAL x75

Cleaning Spring Steel Rods and Patented Stock

IT is generally accepted as true that, given a nearly perfect rod, most wire mill troubles have their source in the cleaning room. This statement is becoming or has become almost too obvious to be included in the literature, and yet how often do we lament our forgetfulness of such truisms.

The Acid Bath

IN the acid bath, the iron oxide scale must be completely removed without pitting or corroding the steel base. Even with the use of the best inhibitors available, spring steel rods or wire may be deeply pitted by sulphuric acid if the pickling temperature is higher than 140°F. The finer wires should be pickled at temperatures between 110°F. and 130°F. to avoid pitting. Acid concentration may vary from 15% down to 5% H_2SO_4. We have found at Keystone that the "black" acid recovered from the oil refineries contains organic compounds which act as extremely efficient inhibitors. When diluted to the required degree, this "black" acid has a very pleasant pungent aroma, is a very effective pickling agent and is economical. After pickling, the spring steel rods or wire should be thoroughly rinsed with fresh water and then inspected for freedom from scale and pitting. Residual scale will of course cut out dies and a pitted surface will also aggravate die wear.

✦ ✦ ✦

The Sull Coat

THE rinsed and inspected rods or wire should then be given a substantial "sull" or wet rust coating, which after liming and baking, serves as a bond or carrier of the drawing lubricant and prevents galling of the steel surface during drawing. The "sull" may be formed by subjecting the work to a water spray or by dipping in a weak acid tub and removing to a "sull" rack, where the wet surface of the work will "sull" without spraying. Time is required for proper "sulling" and must be under control for uniformity.

✦ ✦ ✦

Lime Coating

AFTER proper "sulling", the work should be given a lime coating to neutralize any residual acid and to facilitate lubrication during drawing. Baking the work for three to four hours in an oven at 350°F. to 450°F. is essential to elimination of hydrogen or acid embrittlement and final preparation of the "sull" and lime coating prior to drawing.

✦ ✦ ✦

IN this brief and limited description of spring steel cleaning practice, we can recognize several possible pitfalls which might easily impair quality either directly or indirectly. Only careful supervision and inspection can insure avoidance of these hazards. Positive practice is necessary for positive quality.

✦ ✦ ✦

Ripping The Green Rod After Cleaning

IT is often necessary to draw the cleaned green rod to a smaller diameter prior to patenting and drawing to finished spring wire. In fact, only a relatively few sizes of spring wire can be drawn directly from the patented rods, since the smallest section that can be economically hot-rolled at normal high speeds is the #5 gage rod having a diameter of approximately .207″. As shown in Figs. 3 & 4, the green rod has a coarse crystalline structure consisting of large grains of lamellar pearlite. Where the carbon content is higher than .55%, this hot-rolled structure is the source of deficient ductility with frequent internal and external rupture during severe reduction in drawing. Therefore, care must be taken, in "ripping" or reducing the green rod to the size for patenting, to avoid what has often been called "overdrawing". The green rod may contain segregations of carbon, manganese or phosphorus which would accentuate "tenderness" in ripping. The optimum practice in drawing green rods must be determined in any mill since rod structure varies locally. A conservative rule would read as follows:

Carbon Content	Maximum per Draft	Reduction in Gage Total
.50—.55%	2 sizes	6 to 8 sizes
.56—.70%	2 sizes	2 to 4 sizes

Patenting Spring Steel Rods And Stock Wire

PATENTING is actually a conditioning heat treatment. The procedure usually followed in the patenting of spring steel rods or stock wire is to heat the material in single strands to a temperature (1800°F.-1850°F.) well above the "critical" or transformation range of the steel, holding at heat for a fraction of a minute to allow sufficient grain growth, then cooling in air. The objective effect of this heat treatment is three-fold:

1. Heating above the critical range to completely transform either the hot-rolled or cold drawn structure to a homogeneous solid solution of iron carbide in gamma iron, known metallographically as austenite.

2. Holding at heat to allow growth of large grains of the solid solution, austenite.

3. Cooling in air (or at an equal rate in some other medium) to obtain a uniform dispersion of insoluble spherical particles of iron carbide throughout the mass of alpha iron with the minimum precipitation of free masses of alpha iron at the old austenite grain boundaries. This structure is known metallographically as sorbite or sorbito-pearlite.

✦ ✦ ✦

The Sorbitic Structure

THE sorbitic structure thus obtained in the steel rod or wire by patenting gives higher tensile strength, elasticity, ductility and endurance under repeated stress than the hot-rolled structure of the green rod. Compare Figs. 6 & 7 with Figs. 3 & 4. This patented structure is desirable for subsequent cold drawing especially because of its excellent plastic qualities. That is, because this patented steel consists of a soft iron body or matrix in which there is uniformly dispersed a large number of microscopic particles of hard iron carbide, it will flow readily when subjected to cold work in a single direction as in wire drawing. In such deformation the small

Patented vs. Hot-Rolled Spring Steel Rods

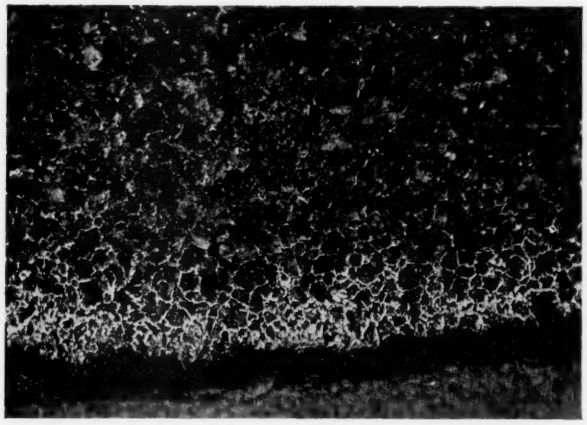

Fig. 3. x100

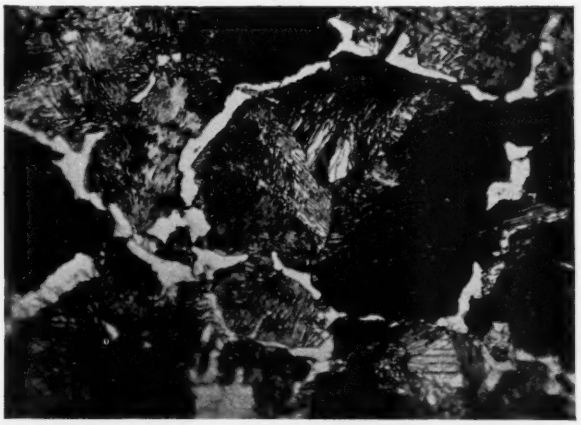

Fig. 4. x1000

Microstructures of 5 ga. Hot-Rolled Rod
Transverse Sections as Etched 2% Nital
Carbon—.61% Manganese—.93% Ult. T. S.—134,600 lbs. per sq. in.

Fig. 5. Same Rod as Above x100
Longitudinal Section as Polished to Show Non-Metallic Inclusions

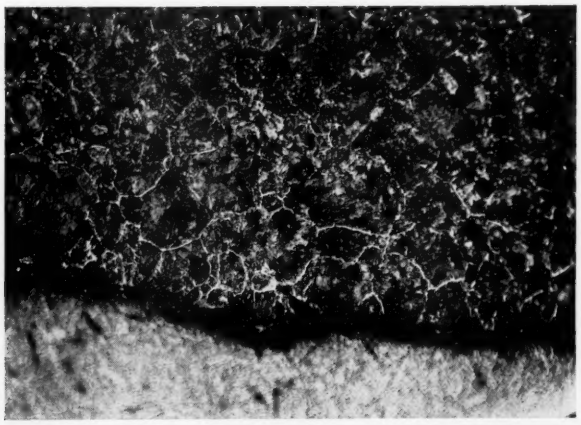

Fig. 6. x100

Fig. 7. x1000

Microstructures of Same Rod After Patenting
Transverse Sections as Etched 2% Nital
Ult. T. S.—142,600 lbs. per sq. in.

spherical particles of iron carbide allow the iron to slip or flow around them in the direction of drawing. A hot-rolled rod, by comparison of microstructures, is less ductile because of the resistance to unidirectional flow of the iron due to the presence of relatively large plates of iron carbide often lying in a position perpendicular to the axis of the rod.

✦ ✦ ✦

High Manganese Content Makes Sorbitization Possible

IT should be mentioned here that the high manganese content of spring wire steel makes possible the more or less complete sorbitization of the steel by air-cooling in single strand from the patenting temperature. If the manganese were as low as .50% to .70% much lamellar pearlite would be formed in the same air-cooling and this would result in lower tensile strength and ductility. This partly explains the generally accepted specification of .90% to 1.20% manganese for spring wire.

✦ ✦ ✦

Sorbitization by Air Cooling

PRACTICALLY of course, no spring steel rod (5 gage or heavier) is completely sorbitized by air-cooling from a patenting temperature of 1800°F.-1850°F. The central portions of the rod obviously cool more slowly than the surface, hence a few grains of lamellar pearlite will be formed near the rod axis. Stock wires drawn from cleaned rods will be more completely sorbitized than green scaly rods of the same diameter, patented and air-cooled under the same conditions, due to the absence of the insulating effect of the scale. Likewise, the smaller the diameter of the stock wire the greater the degree of sorbitization by air-cooling from the same patenting temperature, because of the increased rate of cooling in the smaller cross sections. Thus, the patented stock wire of smaller diameter will usually have a proportionately higher tensile strength, elasticity and ductility. See Table 1.

Air Hardening During Patenting

THERE is the danger of the actual air-hardening of wires finer than 15 gage if overheated when patenting at too slow speeds in the same furnace in which heavier wires and rods are being treated. Such overheated wires will be hard and brittle and will not draw. Such results can be avoided by patenting at higher speeds through the furnace or by patenting in a shorter furnace.

✦ ✦ ✦

FROM these considerations we may assume that satisfactory results in patenting practice can be expedited with the use of the following:

1. A suitably designed patenting furnace.

2. Automatic temperature control for uniform heat treatment continuously in strand.

3. Definite speeds: inversely proportional to some multiple of the respective wire diameters.

4. Effective air cooling.

✦ ✦ ✦

Furnace Design

IT is entirely practicable with a given furnace of proper design to work out a schedule of patenting speeds for the various sizes of wire and thereby patent heavy and light wires as well as rods simultaneously. This cuts down furnace overhead to a minimum and affords sufficient flexibility of patenting practice at all times. There is of course an advantage, when production demand warrants, to operate several furnaces using each for a particular and limited size range of rods or wire. The advantage lies in simplification of operation at each furnace.

✦ ✦ ✦

Heat Application to Rod or Wire

REGARDING heat application to the rod or wire strands travelling through the furnace, three methods may be considered as follows:

(a) Heating in a long, low-arched, gas-fired chamber in full contact with the products of combustion. This gives direct heating by convection of hot gases and by radiation from gases and walls and arch of furnace. Allows use of oxidizing or reducing atmosphere at will.

(b) Heating in similar chamber as above but either internally by electric grids or externally by oil or gas flames. Strands are thus heated almost entirely by radiation.

(c) Passing strands individually through tubes heated externally by oil, gas or electricity. Heat application to strands thus by radiation only.

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Tensile Properties

CONCLUDING this discussion of patenting practice, the table of tensile properties of green and patented rods and patented stock wires shown in Table 1 should be of interest.

✦ ✦ ✦

Drawing Practice

DRAWING equipment used in spring wire production varies with the different mills. Mindful of both quality and economy, one

TABLE 1

Tensile Properties of Green and Pat'd. Rods, etc.

Specimen	% Car.	% Mn.	Gage	Diam.	Ult. T. S. #/sq. in.	% Elong. 10"
Green Rods	.55	1.05	5	.211"	131,800	8.4
Pat'd. Rods	.55	1.05	5	.209"	139,300	7.5
Green Rods	.65	1.05	5	.215"	138,400	9.1
Pat'd. Rods	.65	1.05	5	.212"	141,500	9.0
Pat'd. Wire	.53	.98	14	.079"	149,900	7.8
Pat'd. Wire	.65	1.11	8½	.154"	153,900	7.9

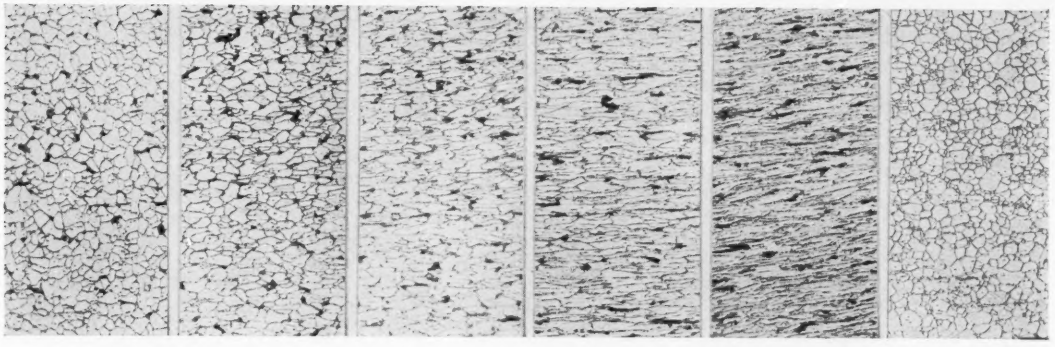
Evolution of 12 ½ Ga. Wire From 5 Ga. Green Rods

Fig. 8

.08% Car.

.32% Mn.

Mgfcn. x120



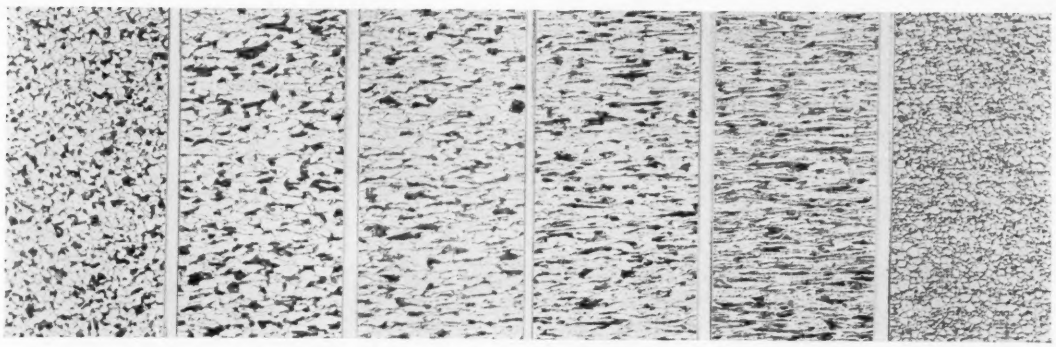
Draft:	Rod	1	2	3	4	Annld. Wire
Diam.:	.218″	.176″	.1425″	.118″	.0965″	.0965″
T. S. p. s. i.	56,500	87,100	104,100	108,500	111,700	51,800

Fig. 9

.21% Car.

.44% Mn.

Mgfcn. x120



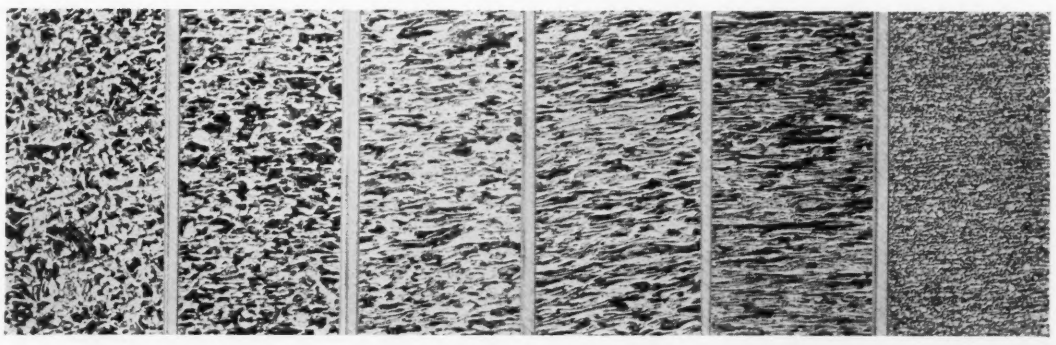
Draft:	Rod	1	2	3	4	Annld. Wire
Diam.:	.211″	.1755″	.142″	.1185″	.0965″	.0965″
T. S. p. s. i.	74,400	102,100	121,300	130,000	142,500	62,900

Fig. 10

.40% Car.

.95% Mn.

Mgfcn. x120



Draft:	Rod	1	2	3	4	Annld. Wire
Diam.:	.218″	.176″	.142″	.118″	.097″	.097″
T. S. p. s. i.	90,000	124,500	146,500	161,000	179,800	79,000

Annealing Note: Three Finished Wires Held at 1320°F. for One (1) Hour.

still has a reasonable scope of selection. The trend is towards a more widespread use of continuous drawing machines. Carbide dies, die cooling, block cooling and wire cooling are recent developments which have made possible higher speeds in the drawing of quality spring wire. Nevertheless, there are limitations, due to the physical endurance of both the material and the operator, which must be considered.

✦ ✦ ✦

What Happens To The Steel During Drawing

SO that we may treat the subject of the drawing of spring wire more comprehensively, let us first consider what apparently happens to the steel during its evolution from green rod to finished wire as revealed by the microscope in the series of photomicrographs shown in Figures 8, 9, 10 and 11.

✦ ✦ ✦

THIS series of photomicrographs and correlated physical data has been used here to show:

(1) The effect of carbon content on structural flow and resultant tensile properties.

(2) The successive structural changes obtained in process.

(3) The role of the ductile iron body or matrix in the drawing of the steel.

(4) The value of suitable heat treatment.

(5) The inherent structural quality of fibrous cold drawn steel wires.

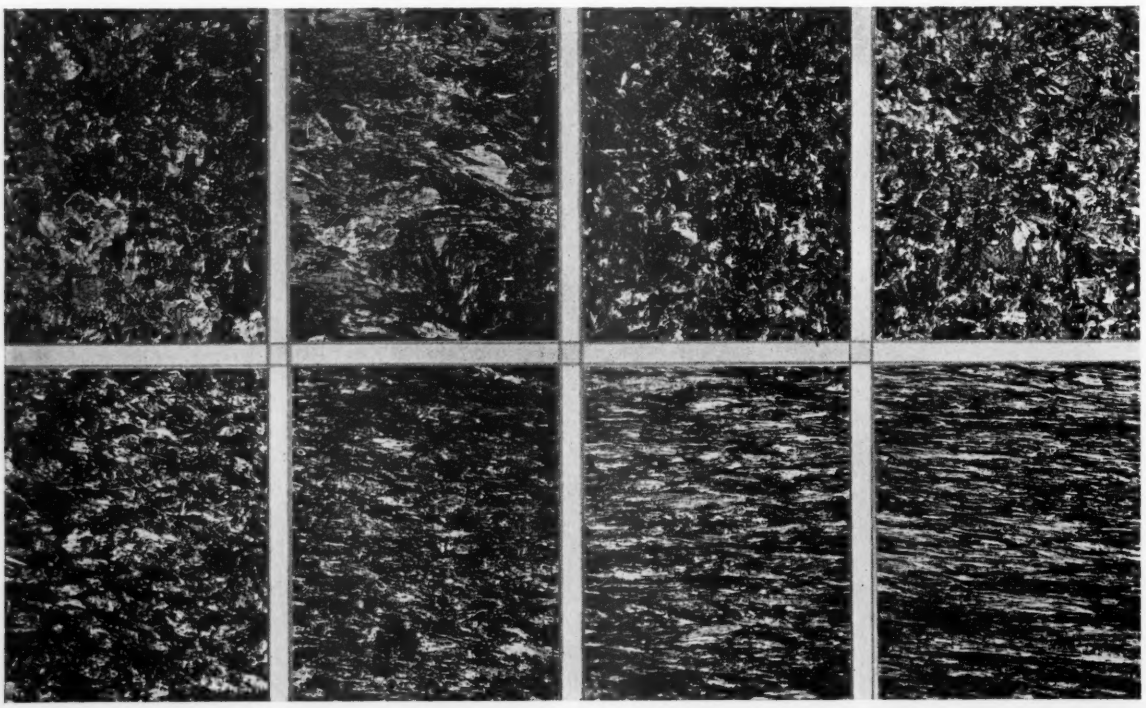
✦ ✦ ✦

Consideration of Effect of Carbon

CARBON, in the form of hard iron carbides, is the prime hardening agent in ordinary steels. It must also be considered as so much interference to plastic flow under cold work. As illustrated in Fig. 9 and Fig. 10, carbide patches or grains will actually resist deformation while the ductile iron grains flow around them and are elongated much sooner in the drawing process. Stray grains of pearlite, with carbide plates perpendicular to the wire axis, are often found only partially deformed in finished spring wire. See Fig. 18. Excessive drawing speeds will cause rupture of such resistant constituents with possible wire breakage. As seen in the graph in Fig. 12, the higher the carbon content the greater the rate of increase in tensile strength or hardness with successive reductions to finish size. Thus, carbon not only gives inherently higher hardness in hot-rolled or annealed steel wires but it also augments the strain hardening effect of cold working.

STRUCTURAL EVOLUTION OF 15 GA. SPRING WIRE FROM 5 GA. ROD

Rod	Ripped 1 Hole	Patented 1800°F.	1st Draft
Diam. .220″	.1665″	.1665″	.150″
T. S. 125,000	169,000	147,000	171,000



2nd Draft	3rd Draft	4th Draft	5th Draft
Diam. .1295″	.1055″	.0855″	.072″
T. S. 186,000	202,000	227,000	248,000

Fig. 11—.67% C. and 1.06% Mn.—Longitudinal Sections—x120 mfgns.

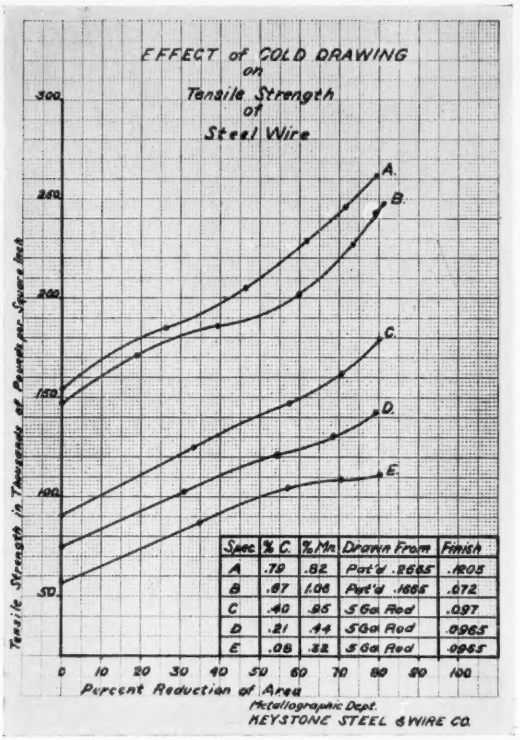

EFFECT of COLD DRAWING
on
Tensile Strength
of
Steel Wire
Tensile Strength in Thousands of Pounds per Square Inch
Percent Reduction of Area
Metallographic Dept.
KEYSTONE STEEL & WIRE CO.
A
B
C
D
E
Spec | % C. | % Mn | Drawn From | Finish
A | .79 | .82 | Pat'd .2665 | .1205
B | .87 | 1.06 | Pat'd .1685 | .072
C | .40 | .95 | 5 Ga Rod | .097
D | .21 | .44 | 5 Ga Rod | .0965
E | .08 | .32 | 5 Ga Rod | .0965

Fig. 12. Curves E, D, C and B were obtained by plotting test results from the same specimens whose micro structures are shown in Figs. 8, 9, 10 and 11 respectively.

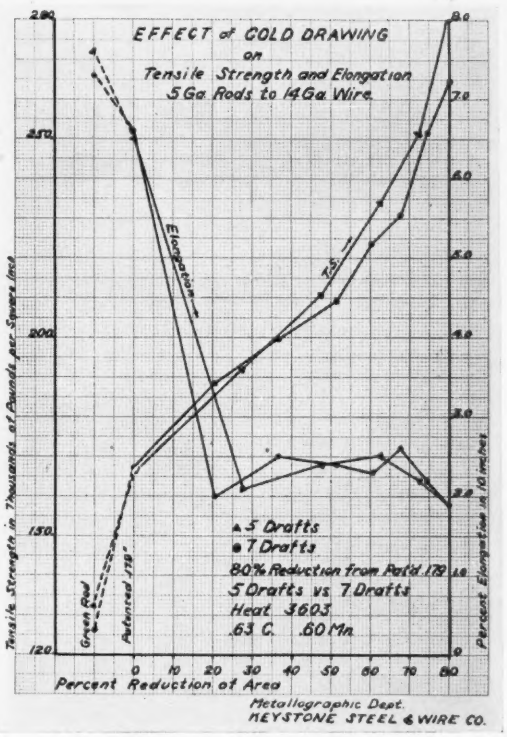


Fig. 13. These curves were obtained by plotting the average tensile test results from sixteen bundles of wire produced under rigid metallurgical control.

Effect of Drastic Reduction Per Draft

DRASTIC reduction in cross sectional area per draft is at best a hazardous practice. The structural effect is illustrated in the second photomicrograph of the spring wire series in Fig. 11. Note the choppy appearance of the pearlite grains due to drastic "ripping" of the 5 ga. green rod to 7½ ga. stock wire prior to patenting.

✦ ✦ ✦

AS stated before, the same rod if patented would be more

Microstructures of .0805" Wires—.63% C and .60% Mn.
Longitudinal Sections

Fig. 14. x100

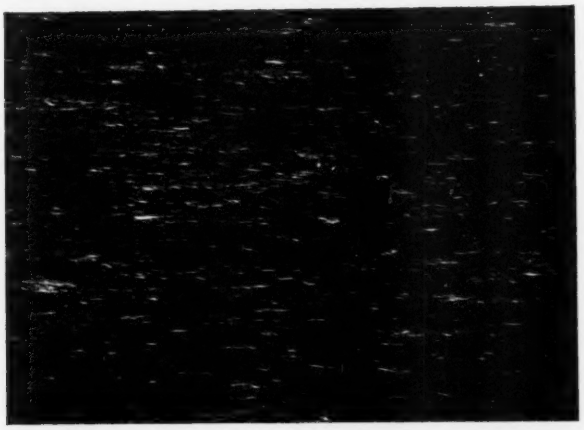


Fig. 15. x100

5 Drafts		Size Patented		7 Drafts
.179"				.179"
27.5%	—	Reduction per Draft	—	20.5%
80.2%	—	Total Reduction—Area	—	80.2%
267,800	—	T.S. in #/sq. in.	—	257,200
1.7%	—	Elongation in 10"	—	1.9%

ductile. The hazard remains nevertheless and must be considered in the final drawing of spring wire from patented rod or stock wire, if possible breakage and non-uniform static and dynamic physical properties are to be avoided in the finished wire. The graph in Fig. 13 and the microstructures in Figs. 14 and 15 demonstrate the relative effects obtained in drawing 14 ga. rope wire from the same .179″ patented salt-quenched stock in five (5) and seven (7) equal reductions respectively. The data is used here to illustrate principles of plastic deformation which apply as well to spring wire production. Note the more uniform fibrous structure and lower tensile strength of the 7 hole wire. Practically, of course, it is possible to make first quality spring wire with a total reduction of 80% in 5 drafts by keeping the wire as near room temperature as possible during drawing.

✦ ✦ ✦

Plastic Deformation by Cold Drawing

PLASTIC deformation of steel by cold drawing involves the generation of heat by internal and external friction and the dissipation of that heat from the wire. If artificial cooling is not utilized, the wire may become so hot as to be "tempered" or age-hardened in process. This effect is not apparent in the microstructure of the wire, but is certainly indicated in the physical properties of the finished or semi-finished wire. For example, such an overheated or tempered wire will have a higher tensile strength and may break in crimping or knotting. Breakage at intermediate or final drafts may be caused by heat accumulation.

In dry drawing, if the patented stock has not been properly cleaned and coated so as to carry sufficient drawing lubricant through several drafts, galling of the wire surface by the die may be accompanied by excessive tempering due to surface friction. The combination of a torn surface and temper brittleness is certain to result in breakage during knotting of coiled springs. Figs. 16 and 17 very definitely illustrate this effect.

✦ ✦ ✦

Lubricants

THE most commonly used lubricant for dry drawing of spring wire is tallow-base soap. Additions of aluminum stearate to such soap increases its heat resistance. The effectiveness of such a drawing lubricant depends largely upon the carrying quality of the "sull" and lime coating previously applied to the patented rods or stock wires after cleaning. Grease mixtures are of course used for special finishes and light total reductions. Provided suitable lubricants (either in suspension or solution) are present in the drawing liquor, wet drawing eliminates the frictional hazards and the cooling problems encountered in dry drawing as discussed above. Wet drawing, however, is used in the production of a relatively small tonnage of spring wire and chiefly for the finer sizes where special bright finishes are required by the purchaser. Lighter reductions and more drafts are required in wet drawing than in dry drawing because of the lower stability of the aqueous lubrication, because of the burnished surface required on the finished wire, and because of the practicability of higher drawing speeds.

✦ ✦ ✦

Factors in Setting Up Schedule of Drawing Reductions

THE combination of tensile strength, resilience and ductility required in spring wire by the spring fabricator is the basic factor in the selection of a schedule of reductions for drawing practice. Usually, the fabricator requires a more or less substantial amount of residual ductility in the spring wire purchased. Therefore, it is impracticable to use the lowest carbon content and the greatest possible total reduction to obtain the required tensile strength. Hence, the use of a rather broad range of carbon contents as previously mentioned. In practice, it is desirable to reduce the number of variables to a minimum and this

Fig. 16. x4 Knotting Break in 14 ga. coiled spring. The dry drawn surface of this wire showed numerous lesions of which the one in Fig. 17 is typical. ✦ ✦ ✦ ✦

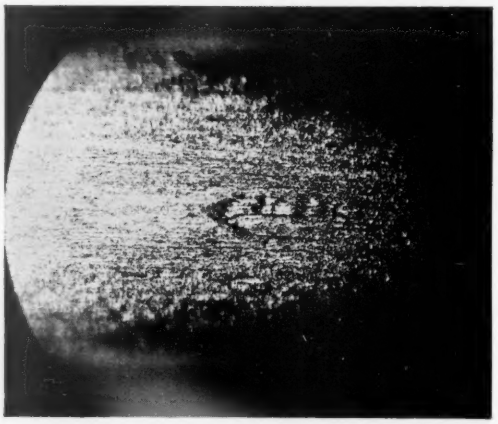


Fig. 17. x25—Galled Surface of wire (near break shown in Fig. 16) due to drastic reduction from poorly coated rod. Etched in 1:1 HCl. ✦ ✦ ✦ ✦ ✦ ✦

applies to both carbon content ranges and reduction schedules. Eighty per cent is a conservative limit for total reduction in cross sectional area from patented stock to finished wire. The number of drafts selected will depend on the total reduction and the type of equipment and lubricant available for production of the finish desired on the wire. These selections must be made on a scientific basis in order to be most effective in standardization of mill production of first quality spring wire with economy.

✦ ✦ ✦

FIG. 18
Photomicrograph of Typical Spring Wire Structure

FIG. 18 is a photomicrograph of an etched longitudinal section of 15½ gage spring wire of normal quality, medium tensile strength and resilience and high residual ductility. The physical and chemical data are underwritten. The microstructure shown is typically fibrous and chiefly sorbitic with a small percentage of lamellar pearlite. The illustration might be labelled "Exhibit A".

Microstructure
15½ ga. Spring Wire

Fig. 18. x1000

Longitudinal Section
Etchant 2% Nital
Diameter .067"
4 drafts from .142 Pat'd. Stock
.59% C and 1.08% Mn.
T. S.—228,900 lbs. per sq. in.

✦ ✦ ✦

Closure

IN preparing this brief treatise, the writer has attempted to disclose certain scientific principles and to indicate their application in the art of making quality cold drawn high carbon steel spring wire. The writer assumes no priority of disclosure and hopes that discussion will develop details which have been omitted, not by evasion, but for the sake of brevity.

✦ ✦ ✦

THE writer wishes here to acknowledge the assistance of the staff members of the chemical, physical, metallographic and operating departments and the encouragement of the management of Keystone Steel and Wire Company, which has been so generously afforded in this work.

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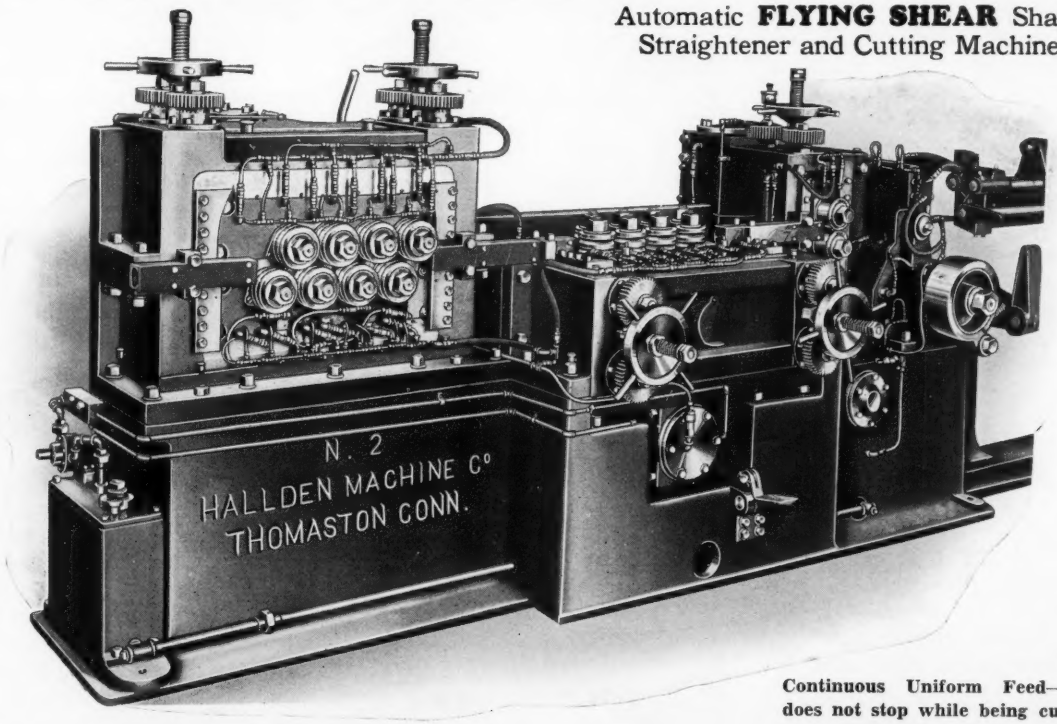

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Corrosion and Hot Galvanizing of Iron and Steel

By Allan B. Dove,

Chemical Engineer, Canada Works, The Steel Company of Canada, Ltd.,
Hamilton, Ontario, Canada

A Paper Discussing the Theoretical and Practical Galvanizing of Wire With Particular Consideration of the Mechanism of Corrosion.

Historical

THE first recorded experiments in the production of zinc coatings by the hot-dipping method appear to be those of Melouin in 1741. Hot tinning was well known in France at this time and Melouin, in his researches into zinc coating, closely copied the progress hitherto applied to tin—namely dipping the sheets in a bath of the molten metal. The results of these experiments, it appears, formed the basis of his report to the Académie Royale in 1742. Kemerlin, in the same year, applied the process to zinc-coated kitchenware, and by 1748 such utensils were known throughout the length and breadth of France.

✦ ✦ ✦

THE next advance was made by Bauchaendorf of Liepzig in 1802 when he introduced salammoniac in place of resinous fluxes. It appears moreover that he had recommended a preliminary coating of tin before immersion in the molten zinc, but this practice was soon discarded, obviously since it was found unnecessary.

✦ ✦ ✦

NEARLY thirty-five years later Sorel was granted a French patent for a zinc coating process which had practically all the essentials of the process as it is known today. His coated products were closely investigated by the French Naval Authorities, who, in turn presented a very favorable report on the resistance to seawater corrosion of articles coated by Sorel's method. It is interesting to note that, at almost the same time, Crawford of England was patenting, in the latter country, an almost identical process, and that Crawford's patent rather than Sorel's is given the credit for the commercial development of the Galvanizing Industry in England and America.

✦ ✦ ✦

THE coating of wire was one of the first large scale commercial applications of the process to be carried out mechanically. It was not until 1846, however, when Morewood and Rogers patented an equipment which controlled the uniformity and thickness of the coating, that any real advance was made in mechanically processing galvanized sheets.

✦ ✦ ✦

IN the last fourteen years much more attention is being focused upon the scientific control and operation of the process, with the result that galvanizing is at last, after two hundred years, assuming its real position in the eyes of investigators.

✦ ✦ ✦

Corrosion And Zinc

WHEN two different metals in intimate contact are exposed simultaneously to corrosive attack by a solution, the one having the greater solution pressure — the more anodic metal—corrodes or dissolves, and by so doing prevents, in a very large measure, excessive attack upon the other.

✦ ✦ ✦

METAL exposed to the atmosphere, even in comparatively dry weather, soon becomes coated with a thin film of moisture. It is therefore in contact with an electrolyte, and passes into solution until the osmotic pressure of its ions becomes equal to the electrolytic solution pressure. In the case of iron, however, another condition arises, namely, the prevention of the state of equilibrium by the formation of an insoluble hydroxide and the removal of ferrous ions from the solution. The

A. B. DOVE

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degree of concentration, therefore, does not correspond to the solution, pressure and as long as water and oxygen are present, the process continues and is assisted by local currents set up as a result of the heterogeneous nature of the iron.

✦ ✦ ✦

IT would appear from the foregoing that, in order to prevent iron from rusting, all possibility of direct contact between iron and an electrolyte must be precluded. This may be done by coating the metal with a sealing layer or by depriving it of the faculty of sending ferrous ions into solution. Rawdon (1) carried out the classic work on preferential attack. His conclusions were, in part, that zinc and cadmium afforded protection by themselves being dissolved, and that it was to the preferential attack of these metals that the protection of iron may be attributed. So long as the coating remains intact—small breaks are still protected—the corrosion resistance of the coating determines the life of the coated article.

✦ ✦ ✦

IT may be interesting to note in passing the nature of the corrosion of zinc itself. It has been shown by Bengough (2) that the corrosion of zinc could be recorded by a straight line, showing corrosion to vary directly with time. J. E. Maconachie, (3) however, in his results has shown that the rate of corrosion of zinc is not constant but rather an alternating factor. He has shown in a series of interesting experiments, that corrosion begins at a number of definite points in sheets, and spreads over the specimen until the original smooth surface is uniformly roughened. This was shown to occur in about 48 hours. Thereafter pitting developed. The problem of periodicity in the dissolution has been studied in detail by Hedges and Meyers (4), and they have shown pronounced periodicity in the rate of evolution of hydrogen. The frequency of the periods was shown to decrease rapidly with time and with decreasing concentration of the reagent in the corroding medium. Maconachie showed that at times the weight of the specimen increased during corrosion, while at others it decreased.

✦ ✦ ✦

IT has been shown by Evans and his co-workers that the corrosion product film on zinc in itself forms an effective barrier to the ready diffusion of oxygen to the metal surface. This corrosion action

$$Zn + 2H_2O = Zn(OH)_2 + H_2$$

has been demonstrated to be reversible, and this may, without great error, be assumed to be the reason for fluctuations in the corrosion of coated metal.

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The Operations of Galvanizing

UNDER this heading will be considered Pickling, Fluxing, and the Hot Galvanizing operation itself. It is a well known fact that the surface of the steel to be galvanized has a profound effect upon the perfection of the finally coated article; if pitted, or even scratched, the resultant gas inclusions produce corresponding roughness of the final coating.

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PICKLING is often considered to be a mere incidental to the galvanizing process, rather than an important operation with far-reaching consequences. As a general rule, wire carries but little appreciable scale so that the pickling operation resolves itself into a mere dissolution of light oxides and iron. Muriatic acid, the usual solvent in hot galvanizing operations, acting upon the oxides causes the formation of ferric, ferrous salts, and water; acting upon iron it forms ferrous chloride and evolves hydrogen. This may be better illustrated by equations:—

1. $Fe_3O_4 + 8HCl = 4H2O + FeCl_2 + 2FeCl_3$
2. $FeO + 2HCl = FeCl_2 + H_2O$
3. $Fe + 2HCl = FeCl_2 + H_2$

✦ ✦ ✦

THE increasing temperature as the wire continues in process will have caused the gas bubbles, which have been intergranularly absorbed, to expand and thereby result in humps beneath the zinc coating. This may, in part, be avoided by maintaining the pickling solution as a low temperature and strength, as may be sufficient for process at the speed used.

✦ ✦ ✦

IT should be remembered moreover, that a hot-water wash after pickling is an absolute necessity since cold water has but little effect when muriatic acid is used as the pickling agent.

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The Fluxing Operation

THE first fluxes applied directly to the bath were organic in nature, until, as already pointed out, Bauchaendorf introduced salammoniac early in the 19th century. It is certain that salammoniac type fluxes react directly with the zinc of the spelter pan, since, if pure NH_4Cl were placed upon the hot metal at the temperatures of galvanizing, 840-880° F., and no combination were possible, it should sublime almost instantly. Actual experiment has shown the vapour tension of ammonium chloride to exceed the atmospheric pressure at 629° F., more than two hundred degrees below the working temperature of the bath. Therefore, since all the flux does not disappear, it follows that chemical combination must take place between NH_4Cl and Zn, and Zn must be taken into the molecule.

"TABLE NO. 1"

"SOLUBILITY OF IRON SALTS IN WATER"

Temperature	$FeCl_2$	$FeCl_3$
	gr/100 cc	
20°C.	40.7	91.8
90°C.	51.3	530.7

The above table will illustrate the effect upon the solubilities of the chlorides of iron in hot and cold solutions, and will emphasize the need of **hot** water as a solvent for chlorides of iron.

THE double salt, zinc ammonium chloride is now widely used in the galvanizing industry, the reason being obvious when the following reactions are considered:

1. $Zn+2NH_4Cl = Zn(NH_3)_2\ Cl_2+H_2$
2. $Zn+(NH_3)_2Cl = Zn(NH_3)Cl_2+NH_3$

✦ ✦ ✦

BY the use of the double salt, the first reaction involving the evolution of hydrogen and resulting in the loss of ammonia in the second, is in part avoided, and the attendant loss of flux is reduced. It has been determined (5) that with decrease of NH_3 content, the flux rapidly loses its power, and new material must be added. The reaction of flux with a metallic oxide is believed to be of the following order:

1. $MO+NH_4Cl = M(OH)Cl+NH_3$
2. $M(OH)Cl+Zn(NH_3)Cl_2 = Zn(OH)Cl+NH_3+MCl_2$

✦ ✦ ✦

The Coating Operation

AS demonstrated by Fig. 1, the hot galvanized coating consists, not of one simple coating but of three rather complex layers. Layer No. 1 consists, in all probability of the brittle $FeZn_3$ while Layer No. 2 is more of the order of $FeZn_7$; we cannot however be definite about these chemical compositions; suffice it to say that the layers decrease in iron and increase in zinc as the outer surface is approached. The breakage of galvanized coatings in bending may be traced to the brittle nature of these alloys. Obviously, the only method of increasing the bending properties of these brittle alloys—apart from galvannealing—is to reduce their depth.

✦ ✦ ✦

WORKING on the theory that the formation of these alloys depends directly upon the rate of dissolution of iron, and that this in turn depends upon the time-temperature factor, the writer conducted a series of experiments upon speed and spelter temperature. Iron dissolution in low carbon steels below 500° C. (932° F.) appears to vary according to the equation (6)

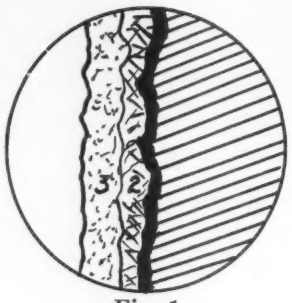

Fig. 1

$$L = n\sqrt{t}$$

where L = Loss of wt. in grs./sq.m.

n = Factor obtained by

$$\text{Log}_{10}N = \frac{-1256}{T+273} + 2.702$$

Where T = Temp. in deg. C.

t = time of immersion in minutes.

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FROM this formula it is evident that a decrease in t or T will result in lowering the loss L.

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WITHIN very certain limits this formula appears to hold true. In the case under experiment 860° F. proved to be the temperature to give minimum alloy thickness. The speed and temperature variations on the particular low carbon stock under tests were as shown on Tables No. 2 and 3.

✦ ✦ ✦

IT is quite apparent that, there is a temperature at which the alloy layer has a minimum thickness and that alloy thickness varies with the speed of the operation. Moreover, from Table 3, it may be seen that temperature is a determinate factor in producing minimum alloy thicknesses. The curve plotted with deposition values vs. temperature is parabolic with its long axis parallel to the deposition axis.

✦ ✦ ✦

IT should be remembered that no coating is produced upon the wire, sheet or casting until the article has reached the temperature of the bath. When the material is removed from the bath, the iron and zinc are above the melting point of pure zinc (419.4°C. or 787°F.). This readily explains spangle formation in sheets. The excess of heat is released, and as the crystals form, the heat of fusion is given up. Since the iron and the zinc alloys are in intimate contact, the heat must pass through the zinc permitting slow cooling and large spangle formation. If, on the other hand, the metal be pitted or irregular, the low conduction of the gases contained in the cavities will result in spotty cooling and irregular spangles. Some importance may thus be attached to large spangles when seeking clean, unpitted galvanized sheets.

TABLE NO. 2

Temperature	Speed	Relative Thickness # 2 Layer
840° F.	21.0 ft./min.	1.5
860°	21.0	1.0
865°	21.0	1.0
875°	21.0	2.0

TABLE NO. 3

Temperature	Speed	Relative Thickness # 2 Layer
860°	21.0	1.5
860°	31.9	1.0
875°	21.0	1.5
875°	31.9	1.0

IN line with this, the writer conducted a series of experiments in order to determine exactly what resulted from long immersion in a galvanizing pot, in relation to alloy thickness. The work was permitted to remain in the pot for various periods, and the alloy thicknesses carefully checked. The figures shown in Table No. 4 were found for unwiped wire at constant speed.

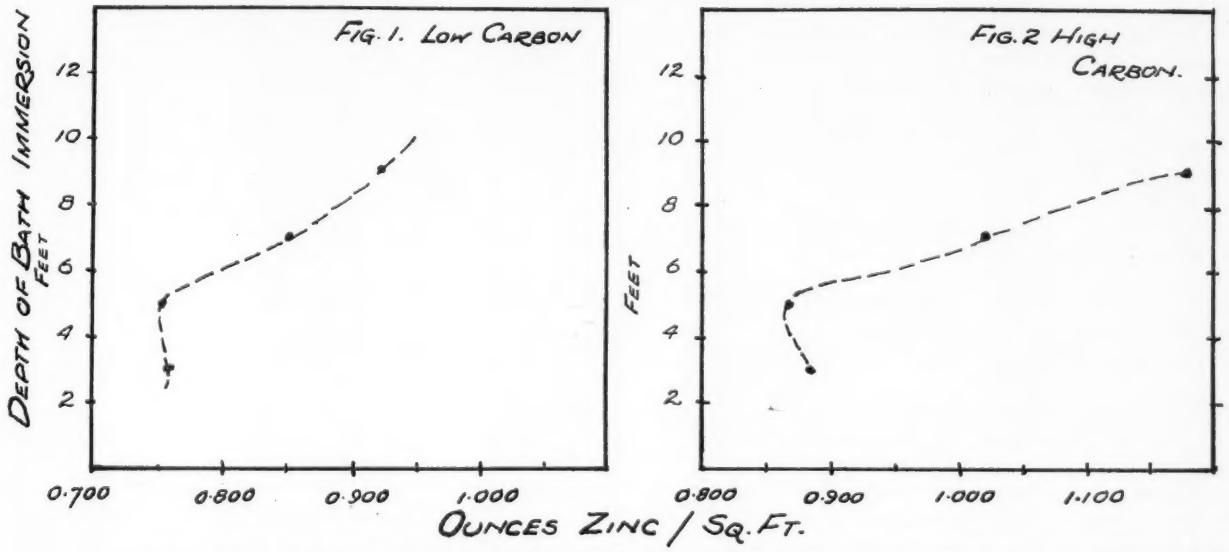
The conclusions which may be obtained from table No. 4 are, in part, illustrated by Graphs 1 and 2 and may be stated as shown under them.

TABLE NO. 4

RESULTS OF SPELTER IMMERSION TESTS

Sample	Carbon	Length of Immersion	Oz./ Sq. Ft.	Immersions Min.	Secs.	%	Alloy Thickness	Total Coating
1.	.04	9.0 ft.	9.22	7	0	60	0.0024"	0.0040"
2.	.04	7.0	8.50	6	0	50	0.0020	0.0040
3.	.04	5.0	7.55	6	15	40	0.0016	0.0040
4.	.04	3.0	7.57	5	0	40	0.0012	0.0030
5.	.68	9.0	1.180	7	0	40	0.0024	0.0058
6.	.68	7.0	1.020	5	15	60	0.0029	0.0048
7.	.68	5.0	.868	5	15	50	0.0020	0.0040
8.	.68	3.0	.888	5	15	40	0.0016	0.0040

GRAPHS 1 AND 2—TOTAL COATING WEIGHT VS. BATH IMMERSION



1. On immersion the wire heats up, iron begins to dissolve, and alloys commence to form. This carries on until after immersion of about six feet, when alloy formation is at its maximum and then the actual pure zinc coating begins in earnest, the dissolution of iron continuing and the alloy formation proceeding at a slower relative rate.

2. The total weight of coating is reduced at about the fifth foot by the dissolution of iron to form heavier alloys.

3. The weight increases after the fifth foot and more rapidly as the time of immersion advances.

IT will be noted that the total weight has not increased in invariable proportion with the total thickness. This is due to the high ratio of the densities of the alloys to zinc.

✦ ✦ ✦

High and Low Carbon Steels

IT is a well know fact that higher carbon steels galvanize more readily and give a more adhering coat than do those of low carbon content. Considering this fact in the light of the alloy formation theory, the bonding structure between metal and alloy $FeZn_7$ is considerably thicker in high carbon stocks. This is clearly shown in the photomicrographs Figs 2 and 3.

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THE second alloy layer is much thinner in the case of the higher carbon stocks. The practical result of these comparative structures, due to the brittleness of the second alloy layer, lies in the fact that the higher carbon stocks may be bent to an appreciable degree before cracks become apparent. As a result, the conclusion may be drawn that the only hope of producing better bending qualities in galvanized wire or sheets is the elimination of the brittle alloy layers. Under present mechanical conditions however, this Utopia is unattainable in hot galvanizing, but by balancing temperatures and time of immersion, as already shown, a condition may be reached which, for each particular stock, will produce maximum bending properties.

✦ ✦ ✦

Dross and Its Formation

IN any spelter pan constructed of iron, there is a certainty of iron contamination and consequent

alloy formation. Of course no alloy will be formed until saturation is completed—at about 1% iron (7) and naturally this condition will become evident more quickly in small pans than in larger ones.

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IF normal operating values were supplied in $L = n\sqrt{t}$, namely T—860° F., t—1 minute, then L = 9.817 grs./sq.m. per min. While this value may appear insignificant at first glance, it, nevertheless amounts to a considerable figure over a period of a few months, and in time the pan becomes worn out. The greatest metal solution generally occurs at the end of the pan where the comparatively cold work enters the spelter. The constant rising of hot metal from the depths of the pan—differences as great as 80 degrees Fah. have been noted between upper and lower layers of the pan—seems to result in the production of eddy currents which in turn produce rapid corrosion of the pan near the end where the work enters.

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THE sudden change in the curve showing variation of iron loss with temperature, (Fig. 4) is due to the fact that at the temperature of 890° F. approximately, there is a sudden change to higher iron alloys. Under 900° F., the alloys show a rhombohedral structure and exist in the form of long slender, needle-like crystals. Above this temperature, they become pyramidical, and are built up of many sided hexagonal plates. As the temperature is increased, the crystals lose zinc.

✦ ✦ ✦

CONSIDERING an equilibrium between iron and zinc at high temperatures, a drop in temperature causes the alloy to take up iron, until the maximum figure is reached just before solidification. The rapid rise in iron content in a galvanizing bath would lead to the conclusion that, in order to prevent excessive drossing and consequent loss of zinc, it is necessary to use a zinc which is low in iron. The A. S. T. M. recommendations are shown in Table 5.

(*Please turn to page 350*)

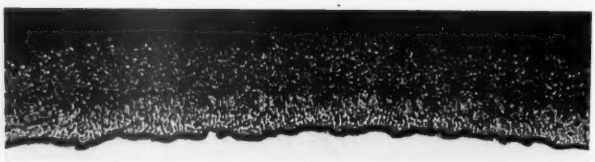

Fig. 2. Microphotograph of .68 Carbon Galvanized Stock x-500.

Fig. 3. Microphotograph of .04 Carbon Galvanized Stock x-500.

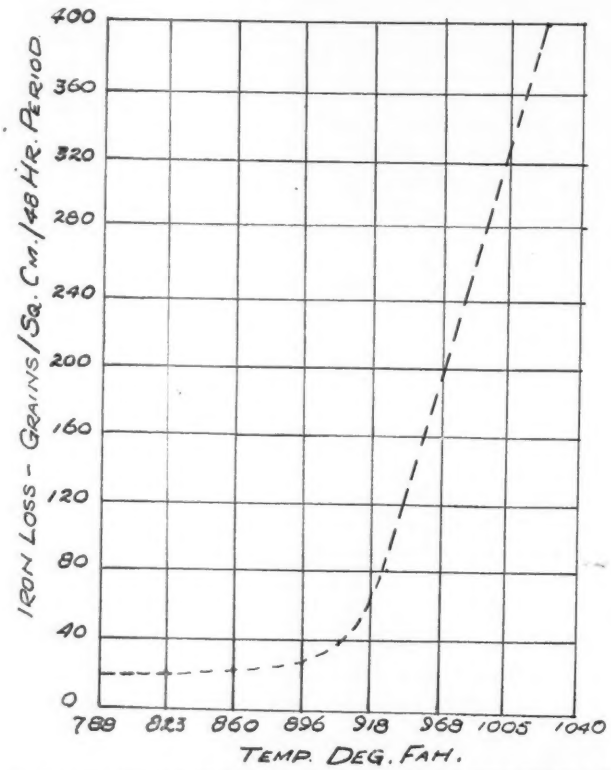

FIG. 4—VARIATION OF IRON LOSS WITH TEMPERATURE

TABLE 5

A. S. T. M. SPECIFICATIONS ON ZINC SLAB

GRADE	Pb Max.	Fe Max.	Cd Max.	Al Max.	Pb+ Fe+ Cd Max.	Spec. A. S. T. M.	U. S. Army & Navy Spec.
Spec. High Grade	0.010	0.005	0.005	0	0.01	Tentative	—
High Grade	0.07	0.03	0.07	0	0.10	1	A
Intermediate	0.20	0.03	0.50	0	0.50	2	B
Brass Special	0.60	0.03	0.50	0	1.00	3	C
Selected	0.80	0.04	0.75	0	1.25	4	D
Prime Western	1.60	0.08	—	—	—	5	E

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Bright Annealing of Wire In Electric Furnaces

By O. S. Haskell,

Industrial Heating Engineering Department, General Electric Company, Schenectady, N. Y.

An Analysis of General Questions in Regard to Electric Furnace Equipment which should be of General Interest to all Manufacturers of Wire and Wire Products.

IN this paper I have tried to answer general questions in regard to electric furnace equipment which should be of general interest to all manufacturers of wire and wire products. These are:

(1) What types of electric furnaces are available and in successful operation in the bright annealing of wire?

(2) What are the applications for these different furnaces?

(3) What are the floor space requirements?

(4) How flexible is the equipment and how can I add to my furnace capacity if required?

(5) How does the time cycle of annealing fit into my production cycle?

(6) What kinds of wire can be bright annealed?

(7) What apparatus is necessary for producing the proper furnace atmosphere?

(8) What metallurgical results are obtained by annealing in the electric furnace?

(9) What surface conditions can be obtained by annealing in the electric furnace?

(10) How does the cost of electric heat compare with my present annealing furnace?

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AS the answer to these questions in full would require the space of a large volume, I hope that the following brief outline will cover the subject except for explicit details.

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Types of Furnaces Available

THERE are three types of electric furnaces available which have been chosen for covering the field of wire annealing most successfully and economically. These are (a) the bell type furnace with a central heating unit as shown in Fig. 1, (b) the bell type furnace with circulating atmosphere as shown in Fig. 2, and (c) the continuous tube furnace as shown in Fig. 3.

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IT should be stated here that these three types of furnaces are chosen because they cover the general field of annealing. However, there are two other types of furnaces which have special applications in which they are particularly useful. These two types of furnaces are the Kenworthy water-sealed electric furnace and the continuous counterflow-pusher type electric furnace.

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Graduated from the U. S. Naval Academy in 1920, and served for six years as an operating engineer in the navy. In 1929 he entered the factory training course of the General Electric Company, following which he was in the manufacturing department. For three years he has been in the industrial heating engineering department of the company, at Schenectady, N. Y.

✦ ✦ ✦

The Bell Type Furnace

THE bell type furnace shown in Fig. 1 consists of multiple bases mounted upon movable cars upon which the load of wire is placed as shown in the right of the figure. The hood or retort is lowered over the charge and is sealed gas-tight by means of a water or oil seal incorporated in the base. Several of these hoods are shown at the left of the figure. The air contained in the charge and in the hood is purged from the hood by introducing a suitable gas atmosphere. The furnace, which is shown partially cut away to show the heating units, is then lowered over the hood by means of the movable crane and the power is applied. As soon as the charge is heated, the furnace is raised and lowered over another hood to heat the next charge while the first is left to cool. All of the parts of this flexible equipment are movable. The crane can carry the furnace, hood or base to any position along the annealing line.

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THE major difference between this furnace and the bell type furnace with a circulating atmosphere is in the construction of the base and the elimination of the central heating unit. As shown in Fig. 4 the base of this furnace is equipped with a motor driven fan which circulates the gas in-

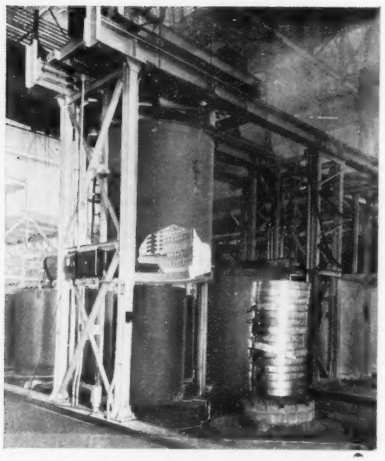

Fig. 1. Bell type furnace installation, cutaway to show central heating unit. ✦ ✦ ✦

side of the hood. The operation of the furnace is the same as for the bell type furnace with central heating unit.

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The Tube Furnace

THE tube furnace, one type of which is shown in Fig. 3, consists of an electric heating chamber through which tubes are passed which tubes a guide for the wire which is threaded through each tube and continuously annealed as pulled through the tubes by a suitable reeling device. A gas atmosphere is introduced into the tubes to accomplish the bright annealing operation. The furnace shown has small tubes installed for round wire annealing.

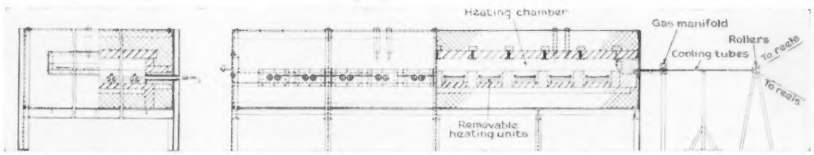

Fig. 3. Continuous wire annealing furnace. ✦ ✦ ✦

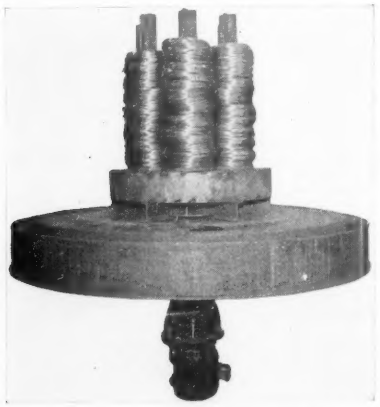

Fig. 4. Typical load of small coils of steel wire.

Bell Type Furnace With Central Heating Unit

THE bell type furnace with central heating unit is used for annealing large loads of flat wire, round wire or strip. The coils must be of sufficient size and wound on a large enough mandril so that the central heating unit can extend down the hollow center of the stacked wire. A typical charge is shown in Fig. 1.

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Bell Type Furnace With Circulating Atmosphere

THE bell type furnace with circulating atmosphere is a general annealing furnace for all sizes and shapes of wire in coils or on spools or reels. Typical loads are shown in Fig. 4 and 5.

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Continuous Tube Furnace

THE continuous tube furnace is used for the finish anneal of those alloys in which time is an important factor in determining the surface condition after annealing. Some of these metals are brasses, phosphor bronze and stainless steel. This type of equipment is more suitable for fine or thin wire than it is for heavy sizes.

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Uses For Special Types

THE bell type furnace with a central heating unit has been built principally in one size to accommodate the average sized coils used by some of the largest wire mills. The coils are approximately 33 inches in diameter and the furnace takes a charge 54 inches high weighing an average 9000 pounds.

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THE bell type furnace with a circulating atmosphere has been designed in four standard sizes, based upon various types of loading. They were laid out keeping in mind the standardization of sizes for coils, reels and spools of wire as outlined by the Wire Association. These four sizes anneal loads varying from 2000 pounds to 10,000 pounds.

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Fig. 2. Bell type furnace installation with circulating atmosphere. ✦ ✦ ✦ ✦

Sizes of Different Type Furnaces

THE size of the continuous furnace depends upon the desired output per hour and the operating temperature. In general, the greater the desired output and the lower the temperature the longer the furnace must be. The width of the furnace is limited to

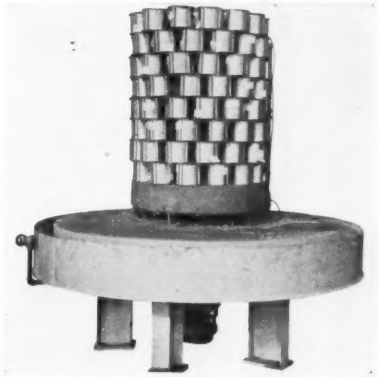

Fig. 5. Typical load of small reels of copper wire.

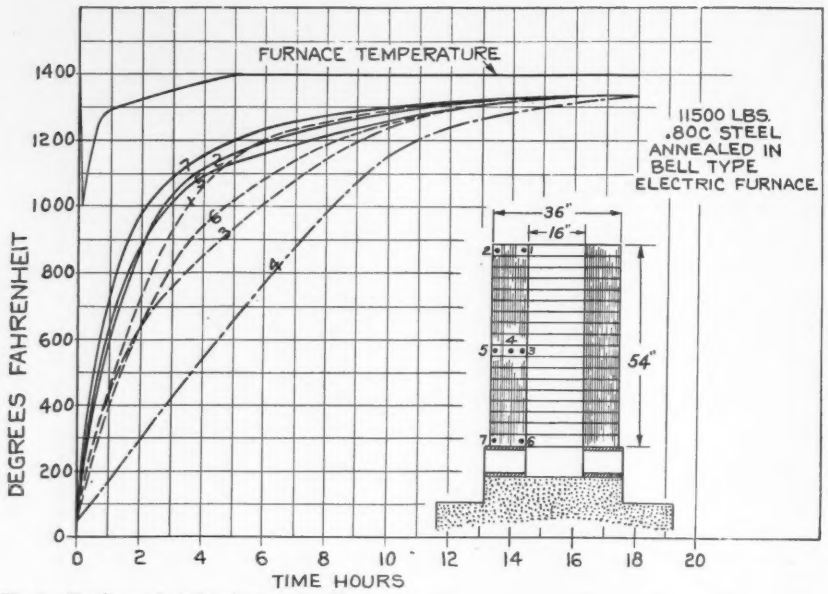

Fig. 7. Heating and Cooling Curve. See Fig. 1.

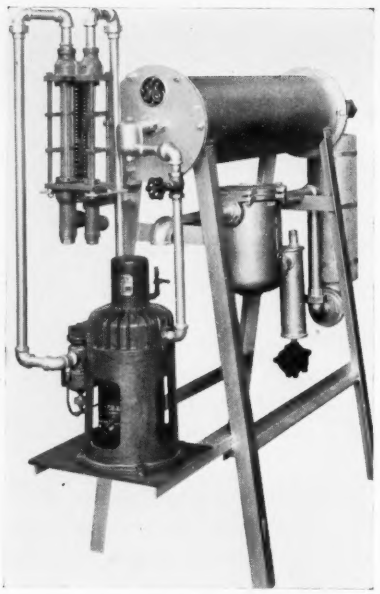

Fig. 6. Combustion-type furnace—atmosphere controller.

the reeling device and the ability of the operator to reach the various parts of the external equipment.

✦ ✦ ✦

THE floor space required for the bell type furnace with central heating unit averages 12 sq. ft. per ton per twenty-four hours. The floor space required for the bell type furnace with circulating atmosphere averages 8 sq. ft. per ton per twenty-four hours. The floor space required for the continuous furnace varies greatly with capacity.

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Bright Annealing Furnace Atmospheres

COPPER, low carbon steel, high carbon steel, monel metal, brasses and bronzes have been successfully bright annealed in electric furnaces. Starting with a gas-tight furnace, bright annealing is accomplished by heating the charge in the proper furnace atmosphere. This furnace atmosphere is made up from two sources —the gas admitted into the furnace to exclude the air, and the gas formed by the rolling oil or drawing compound which is on the suface of the charge as well as gases which in some cases come from the metal itself. In every case the gas atmosphere admitted to the furnace must be such that it will not stain the surface with oxides, sulphides, or carbon deposits, or destroy the metallurgical properties of the metal; also, the rolling oils and drawing compounds used should have the same characteristics, and be so easily vaporized that they will leave no residue upon the surface of the charge.

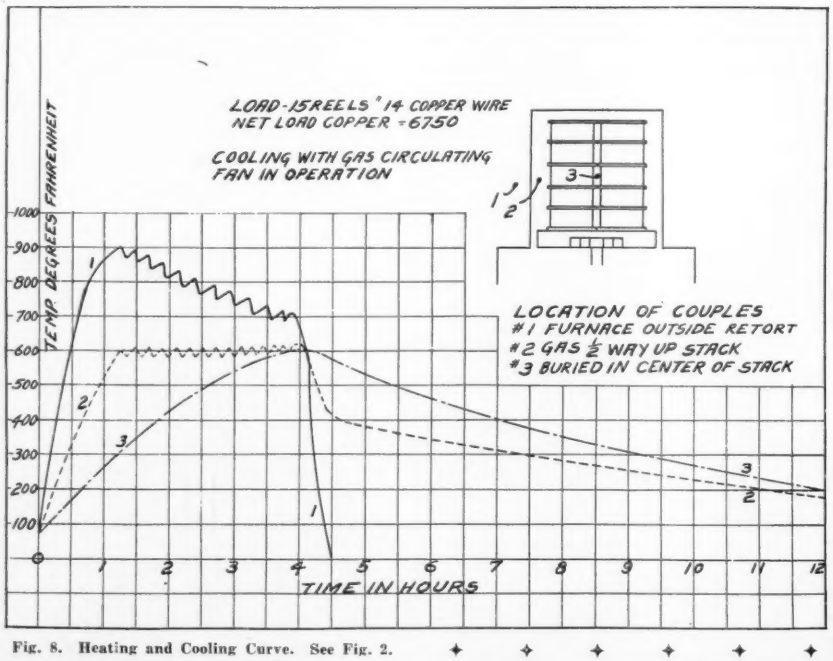
LOAD-15 REELS #14 COPPER WIRE
NET LOAD COPPER =6750
COOLING WITH GAS CIRCULATING
FAN IN OPERATION
LOCATION OF COUPLES
#1 FURNACE OUTSIDE RETORT
#2 GAS ½ WAY UP STACK
#3 BURIED IN CENTER OF STACK
TEMP DEGREES FAHRENHEIT
TIME IN HOURS

Fig. 8. Heating and Cooling Curve. See Fig. 2.

✦ ✦ ✦

Copper

COPPER, in general, can be bright annealed in any non-oxidizing atmosphere which is free of sulphur products. At high temperatures, however, the atmosphere must be carefully controlled or the copper will become brittle from deoxidation of the copper.

Low Carbon Steel

LOW carbon steels can be successfully bright annealed in furnace atmospheres in which the relations between hydrogen and water vapor, carbon monoxide and carbon dioxide are held in the proper ratios.

✦ ✦ ✦

High Carbon Steel

HIGH carbon steels must be annealed in atmospheres which will not decarburize the surface.

✦ ✦ ✦

Monel Metal

IN bright annealing monel metal the moisture content of the furnace atmosphere must be carefully controlled.

✦ ✦ ✦

Brasses And Phosphor Bronzes

THE bright annealing of brasses and phosphor bronzes in general is governed largely by time and temperature in the heat. Brasses low in zinc have been successfully bright annealed at usual production temperatures. But brasses, high in zinc, and phosphor bronze cannot exceed limited temperatures for any length of time without becoming discolored due to the distillation of zinc or tin and probably gases from the metals themselves. In stainless steels, chromium causes the trouble. However, all of these metals can be subjected to an anneal below these limiting temperatures with bright annealing results entirely satisfactory for many processes.

✦ ✦ ✦

Gasses For Producing Atmosphere

THE gases used for producing the atmosphere for bright annealing may be supplied from tanks or from special gas producers. Tanked nitrogen or hydrogen or other tanked mixed gases are too costly for most installations and are not usually suitable for furnace atmospheres. Coke oven gas or natural gas can be used with success in some applications but the explosion hazard is high and they are far from being ideal furnace atmospheres. A mixture of dry hydrogen and nitrogen can be obtained by dissociating anhydrous ammonia. This gas has its advantages for some applications. Coke oven gas, natural gas, and butane can be "cracked" in the presence of water vapor to produce an atmosphere high in hydrogen and carbon monoxide, which has its proper application.

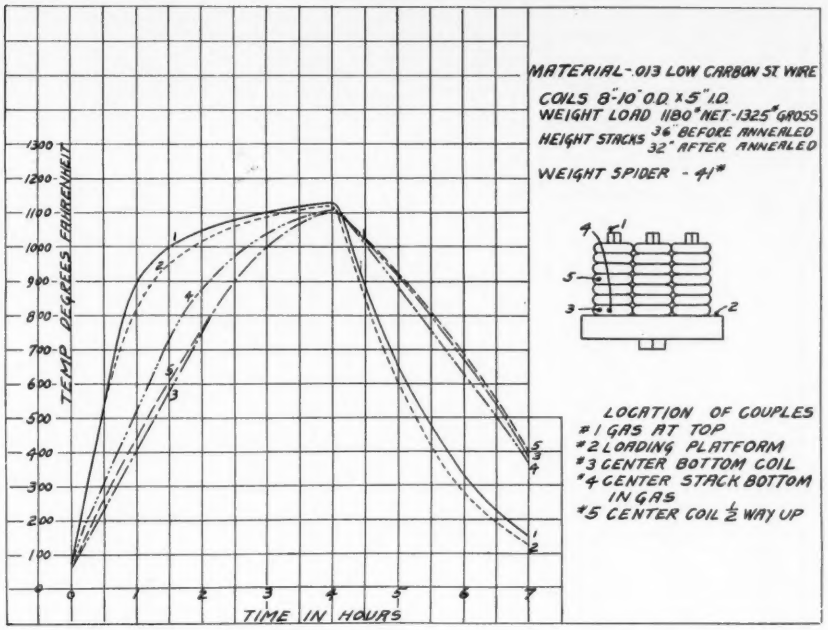
MATERIAL - 013 LOW CARBON ST WIRE
COILS 8"-10" O.D. x 5" I.D.
WEIGHT LOAD 1180# NET - 1325# GROSS
HEIGHT STACKS 36" BEFORE ANNEALED
32" AFTER ANNEALED
WEIGHT SPIDER - 41#
LOCATION OF COUPLES
#1 GAS AT TOP
#2 LOADING PLATFORM
#3 CENTER BOTTOM COIL
#4 CENTER STACK BOTTOM IN GAS
#5 CENTER COIL ½ WAY UP
TEMP DEGREES FAHRENHEIT
TIME IN HOURS

Fig. 9. Heating and Cooling Curve. See Fig. 4.

✦ ✦ ✦ ✦ ✦ ✦

Combustion Type Furnace Most Universally Usable

BUT the most universally usable apparatus for producing furnace atmospheres has been supplied in the combustion-type furnace —atmosphere controller (Fig. 6). This apparatus produces the cheapest and most easily controllable furnace atmosphere. This

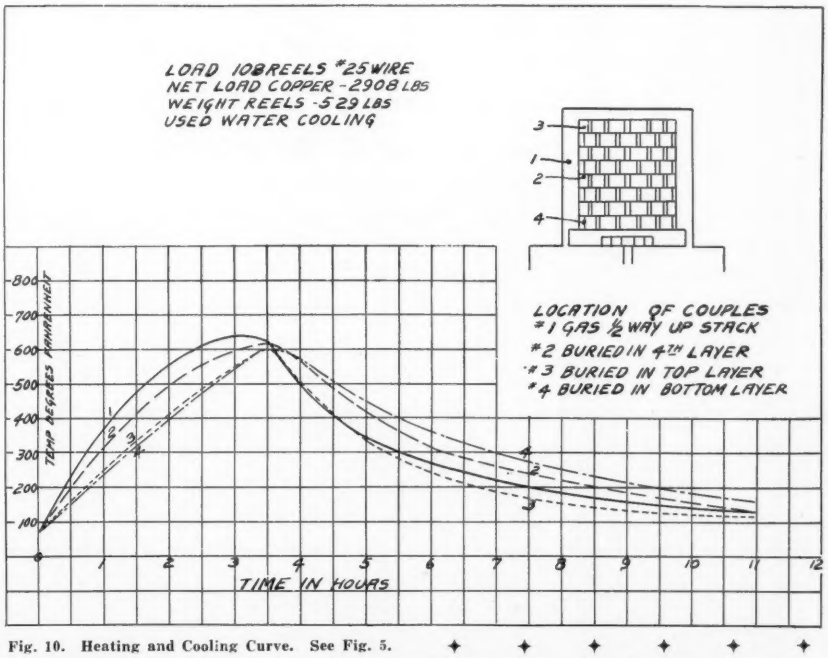
LOAD 108 REELS #25 WIRE
NET LOAD COPPER - 2908 LBS
WEIGHT REELS - 529 LBS
USED WATER COOLING
LOCATION OF COUPLES
#1 GAS ½ WAY UP STACK
#2 BURIED IN 4TH LAYER
#3 BURIED IN TOP LAYER
#4 BURIED IN BOTTOM LAYER
TEMP DEGREES FAHRENHEIT
TIME IN HOURS

Fig. 10. Heating and Cooling Curve. See Fig. 5.

✦ ✦ ✦ ✦ ✦ ✦

TABLE I

TESTS ON WIRE ANNEALED IN ELECTRIC FURNACE

Sample Number	Dia.	Tensile Strength Actual	Tensile Strength lbs/sq. in.	% Elonation in 2"	Rock "B"
1	.510 x .105	2315	43200	44.0	38-39
2	.507 x .1045	2310	43600	44.0	38-39
3	.516 x .1055	2315	42500	45.0	37-38
4	.514 x .105	2320	43000	45.0	38.5–39.5
5	.508 x .106	2385	44300	42.5	39-41
6	.519 x .1055	2345	42800	41.0	36.5–40
1	.432 x .064	1265	45800	39.5	43.5–45
2	.439 x .0625	1280	46650	41.0	46–46.5
3	.432 x .065	1285	45800	39.5	45.5–45.5
4	.433 x .065	1310	46600	38.0	47–49
5	.430 x .064	1265	46000	42.0	45–46
6	.430 x .0625	1255	46700	42.5	45–47
1	.754 x .022	755	45500	46.0	40–41
2	.752 x .024	780	43200	42.5	32–33
3	.754 x .022	715	43100	47.5	31–33
4	.754 x .0225	731	43000	46.0	32.5–33
5	.753 x .022	700	42300	47.0	31–31
6	.753 x .024	800	44250	40.0	33–34
1	.752 x .0415	1290	41300	45.0	33–33
2	.749 x .041	1315	42800	43.5	35–36
3	.750 x .039	1220	41700	49.0	34–35
4	.750 x .0395	1270	42900	46.5	39.5–40
5	.751 x .0395	1235	41600	49.0	33–33
6	.750 x .039	1190	40700	51.5	31.5–32

TABLE II

COMPARATIVE OVER-ALL COST OF HIGH CARBON STRIP

	Annealing Method	
	Electric Bell Type Cost per Ton	Oil Furnace Pots Cost per Ton
Depreciation	0.44	0.33
Interest and taxes	.32	.26
Labor	.60	1.38
Pot replacements		.80
Chips and borings		.03
Maintenance	.03	.09
Gas for atmosphere	.128	
**Electric energy at 1 cent per kwhr.	2.10	
*Oil at 6½c per gallon		2.82
Protective hoods	.22	
Total	3.838	5.72

Saving per ton by electric equipment—$1.87 for high carbon steel.

**Includes energy for gas purifier and winch motor.

*Includes storage, pumping and atomizing costs and interest on investment.

apparatus produces a furnace atmosphere at a figure averaging one-third of the cost of coke oven gas, one-sixth the cost of natural gas, and one-twentieth of the cost of butane. It supplies a gas which can be humidified to any desired dew point or dried to any desired amount. The same apparatus can supply a gas of such varying analysis that it covers nearly the entire range of bright annealing.

TABLE III

OPERATION FROM STANDPOINT OF ECONOMY

Date May 1933	Reels	Size Wire	Total Wgt. Net Pounds	Temp. in Retort °F.	Kwh.	Pounds Per Kwh.
8	13	14	7500	600	172	43.6
9						
10	8	14	4800	600	145	33.
11	46	22	6200	500	137	45.3
	Small	24				
12						
15	10	14	6000	600	171	35.
16	8	14	4000	600	145	27.6
17	15	Empty	1400	780	92	
			Reels only			
18	13	14	6550	600	173	37.9
19	8	14	4800	600	136	35.3
22	13	14	7860	600	190	41.

✦ ✦ ✦

Metallurgical Results Obtained By Electric Furnace Use

THE metallurgical results obtained by using the electric furnace are excellent. The heating and cooling curves, Fig. 7, 8, 9 and 10 show the cycles corresponding to the loads pictured in Fig. 1, 2, 4, and 5. The tabulation of metallurgical results, Table I, given for a load of low carbon steel wire speaks for itself.

✦ ✦ ✦

Cost of Electric Heat

THE cost of electric heat will be found to be surprisingly low as compared to older annealing processes. Table II shows the cost of annealing a charge of high carbon steels trip similar to the load shown in Fig. 1. Table III shows the operation from the standpoint of economy for charges similar to that shown in Fig. 2.

QUESTIONS ?

SHOULD the Wire Association technical sessions and discussions raise doubts as to the correct processing equipment, we offer our consultant services.

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Lime Coating of Rods vs.---What?

By Harold G. Hobbs,
Cleveland, Ohio.

A brief report on experiments with Silicate of Soda and Tri Sodium Phosphate as substitutes for Lime in the coating of wire rod prior to drawing.

THIS article is submitted to the members of the Wire Association, not with a view to setting up the advantages and disadvantages of any products which might be used in place of lime for the coating of wire rods, but with a view to passing along information on recent developments in the attempt to evaluate silicate of soda and tri sodium phosphate as a substitute for lime. Therefore it must be recognized that the province of the writer in connection with this article is that of an interested reporter, and not that of an authority on coatings for wire rod prior to drawing.

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History of Lime Coating of Wire Rod

RESEARCH has not brought to light any authentic historical data pertaining to the first use of lime in the drawing of wire rod, and the reasons why it became the universal medium.

✦ ✦ ✦

IT has been stated that lime coating with subsequent baking was used in England as far back as 1860 *1; and Appleton's Cyclopaedia of Applied Mechanics, Volume II, 1880, contains the following statement:

"The cleaning process consists in dipping the coils in vats containing dilute sulphuric acid until the surface is sufficiently attacked. Further action of the acid is arrested by dashing a mixture of lime and water over the coils as they lie upon the ground. After drying in a large oven, the wire is ready for the drawing process."

*1. History of Wire Drawing by P. Longmuir and J. Kenworthy, Publication English Engineer, April 18, 1913.

Copyright 1934, H. G. Hobbs.

FROM this, the use of lime would appear to date back some seventy to eighty years, during which time it has supplanted soda ash, starch, flour and other mediums possessing the same physical properties. Such data as is available would indicate that these other mediums were tried and found successful, that lime won out principally on the point of low initial cost and consumption and not because of its superior applicability.

HAROLD G. HOBBS

Born at West Point, Ala. Majored in Metallurgy at University of Toronto. Five years service with Canadian Army and Royal Air Force. Engineer Pennsylvania Salt Mfg. Co. Member Wire Association. Seven years Sales and Technical Service Engineer in Tool Steel and Chrome Nickle Alloy. Five years research and sales engineer heavy chemicals for pickling, galvanizing and tinplating steel.

Purposes of Lime Coating of Wire Rod

LIME coating of wire rod has three primary purposes: it acts as a neutralizer of any acid which may carry over from the pickling of the rod; it is a rust preventive; and it serves as a bond between the rod itself and the lubricant used in drawing it down to a smaller size. It follows, therefore, that any substitute for lime would not only have to have these qualifications, but would also have to have other features of merit before it could be seriously considered in place of lime.

✦ ✦ ✦

Research For Substitutes For Lime

IT is evident that no manufacturer of any product which might compete with lime in this service has ever made any determined or continued effort to wholly or partially supplant lime with his product, with the result that today lime is practically the only medium used by the rod and wire industry for performing the work it is doing. Spasmodic attempts by a few mill operators of an investigative frame of mind have been and are being made in an attempt to use other mediums, such as silicate of soda and tri sodium phosphate; but in most cases these endeavors have never progressed beyond what might be called the preliminary stage, all efforts being discontinued at the first sign of trouble; a fact which is verified by the contradictory results obtained in the various plants which have experimented in

the use of either or both of these substitutes. Although investigation would seem to indicate that while there are no fundamental obstacles to the use of mediums other than lime which can not and would not be eliminated with education and a proved practice, thought must be given to the fact that thorough research may sustain these obstacles.

✦ ✦ ✦

WHILE all the data obtained in connection with this article shows 42 degree Baume silicate of soda (which has a ratio of one part soda (NA_2O) to 3.25 parts silicate (SiO_2), to be the only grade so far used in work of this nature, it has been suggested that 34 degree Baume (which has a ratio of one part soda to 3.7 parts silicate) may be more suitable, inasmuch as it would deposit a coating "slippery" in texture, although just as porous as the coating left by the 42 degree material.

✦ ✦ ✦

BEFORE attempting to point out the advantages and disadvantages which have come to light during experimental work with silicate of soda and tri sodium phosphate, attention is called to the varying results obtained from such work, some directly contradictory to others, so much so that the following list of advantages and disadvantages must necessarily be subject to challenge.

✦ ✦ ✦

Indications of Preliminary Experiments

BEARING in mind the preceding paragraph, preliminary experiments would tend to show that silicate of soda and/or tri sodium phosphate have certain advantages over lime. The use of either or both of these products would eliminate the present baking operation; wire drawn from rods coated with these products are much lighter in finish, have an exceptionally high polish and sheen, with an absence of coating streaks; and it is possible to obtain that classification of wire known as "extra bright" with only a one or two hole drawing.

IN addition, rods coated with either or both of these products show less tendency towards rusting, not only when they are in the coated stage and before drawing, but also after drawing when they are a finished product.

✦ ✦ ✦

LABOR and equipment costs in preparing either or both of these products are much less than what they are in preparing lime inasmuch as the latter calls for slacking and seasoning before being added to the lime tub, whereas silicate of soda or tri sodium phosphate are added as purchased, direct to the coating tub, in quantities sufficient to give the desired alkalinity.

✦ ✦ ✦

THE consumption of either or both of these products, per ton of rod coated, runs approximately seventy to eighty per cent less than lime. This factor, plus the elimination of baking, would tend to more than offset the difference in their initial costs as against the initial cost of lime. The average cost of silicate of soda in carload lots is from twelve to fourteen dollars a ton; that of tri sodium phosphate fifty dollars a ton; and that of lime from six to fifteen dollars a ton.

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ON the other hand, these same preliminary experiments have brought to light certain disadvantages which may or may not be overcome by further and more intensive effort on the part of anyone sufficiently interested to definitely evaluate these two products.

✦ ✦ ✦

THE susceptibility of wire rods to hydrogen embrittlement while being pickled is such, if the operation is not supervised and controlled, that without baking and the removal of this embrittlement, trouble is encountered in subsequent operations, especially if the wire is subjected to severe crimping.

✦ ✦ ✦

SMALL gauges of rod and wire can not be coated with either or both of these products as they nest too tightly when in coil form, which prevents quick and thorough drying from the heat absorbed during the immersion in the coating tub.

✦ ✦ ✦

RODS coated with either or both of these products can not be drawn more than one or two holes without a high percentage of scratching and excessive wear and tear on the die.

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WHILE it has been found that a solution can be made up of either or both of these products sufficiently heavy in alkalinity as to allow the drawing of more than one or two holes, this is economically impractical as the resultant coating would not be self-drying and would necessitate baking, thus eliminating one of the chief advantages claimed for these products.

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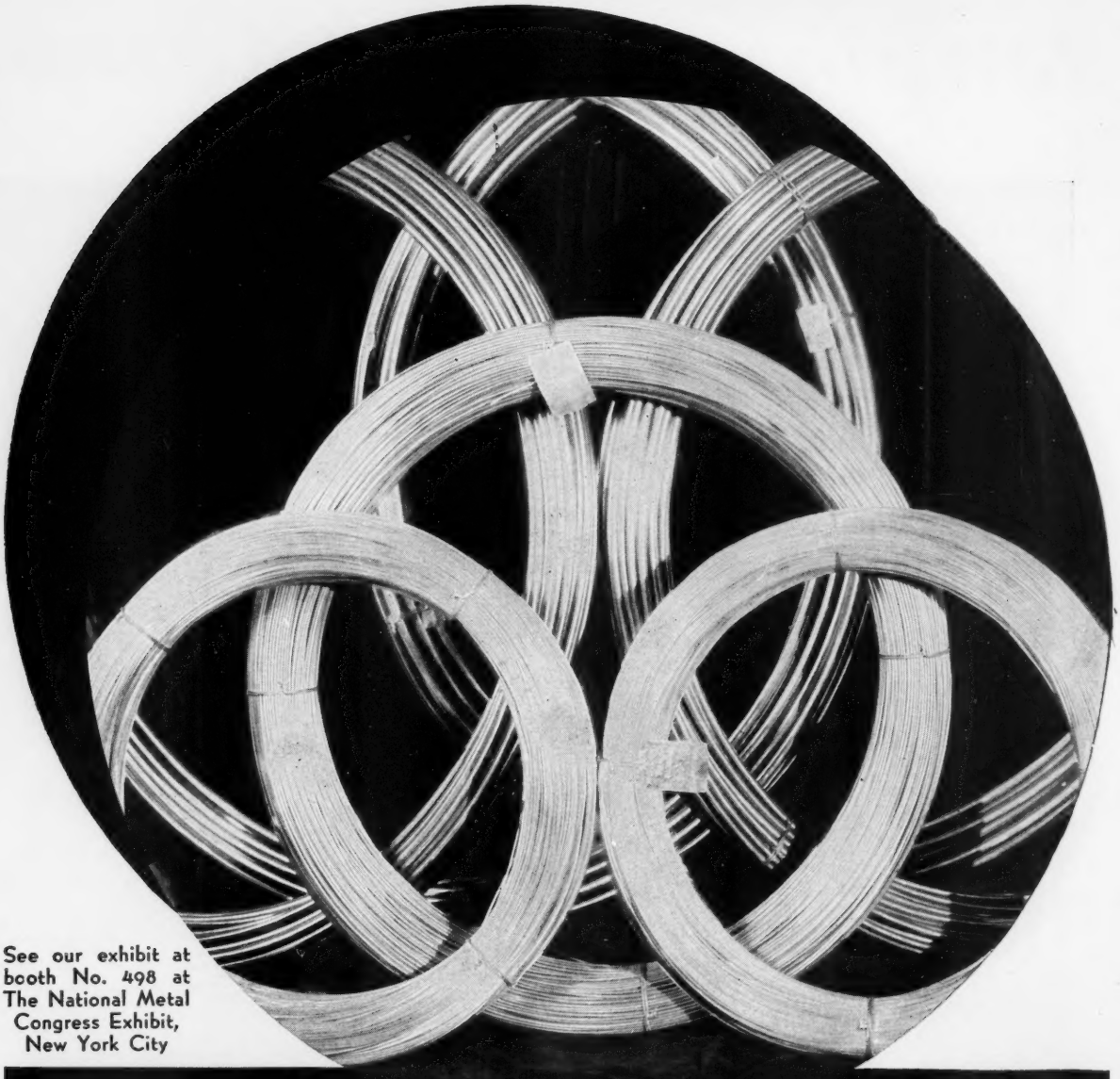
THE use of silicate of soda alone is questionable as it is claimed that this coat would be too brittle and crystalline when dry, and would crack and fall off leaving the rod bare of this necessary bond and carrying agent.

✦ ✦ ✦

THE use of either or both of these products would tend to produce caustic embrittlement. However, it was impossible to obtain any authoritative first hand information on caustic embrittlement and the possible effect on wire rod subjected to it; just what percentage of alkalinity would subject the coated material to this embrittlement; the length of immersion in the hot solution before the danger became imminent; how it could be determined whether the coated rod might be impregnated with this embrittlement; and what steps would have to be taken to eliminate it if it were found. In fact, the matter of caustic embrittlement in steel, in so far as the subject covered by this article is concerned, would appear to be an unknown "bug-a-boo" about which we have all heard, but which few have ever encountered.

✦ ✦ ✦

ENDEAVORS to use silicate of soda and/or tri sodium phosphate as a substitute for lime with the consequent elimination of bak-



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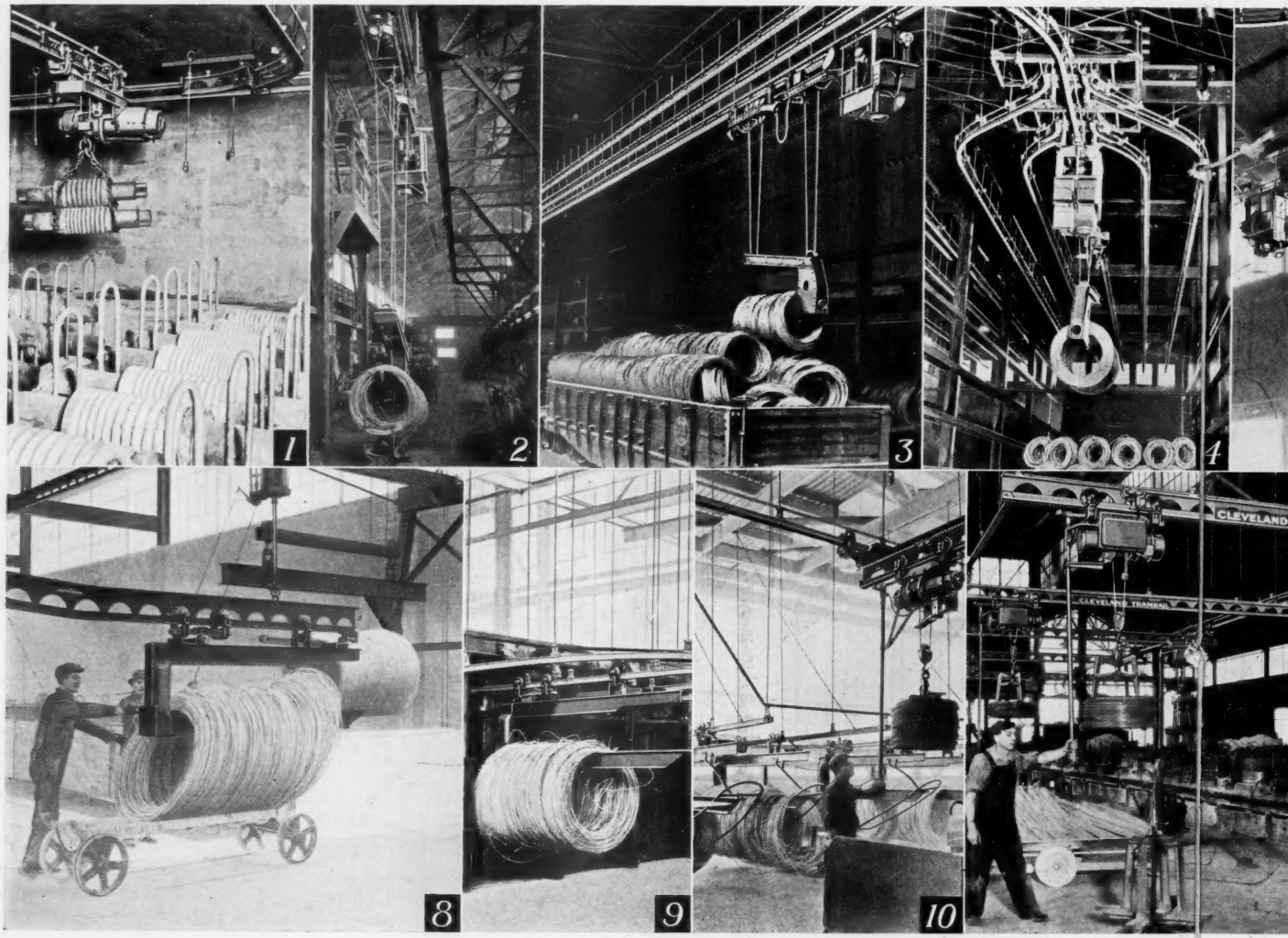

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5. Weighing enroute on Scales built into the Cleveland Tramrail System
6. Single Leg Gantry Crane in the cleaning house
7. The
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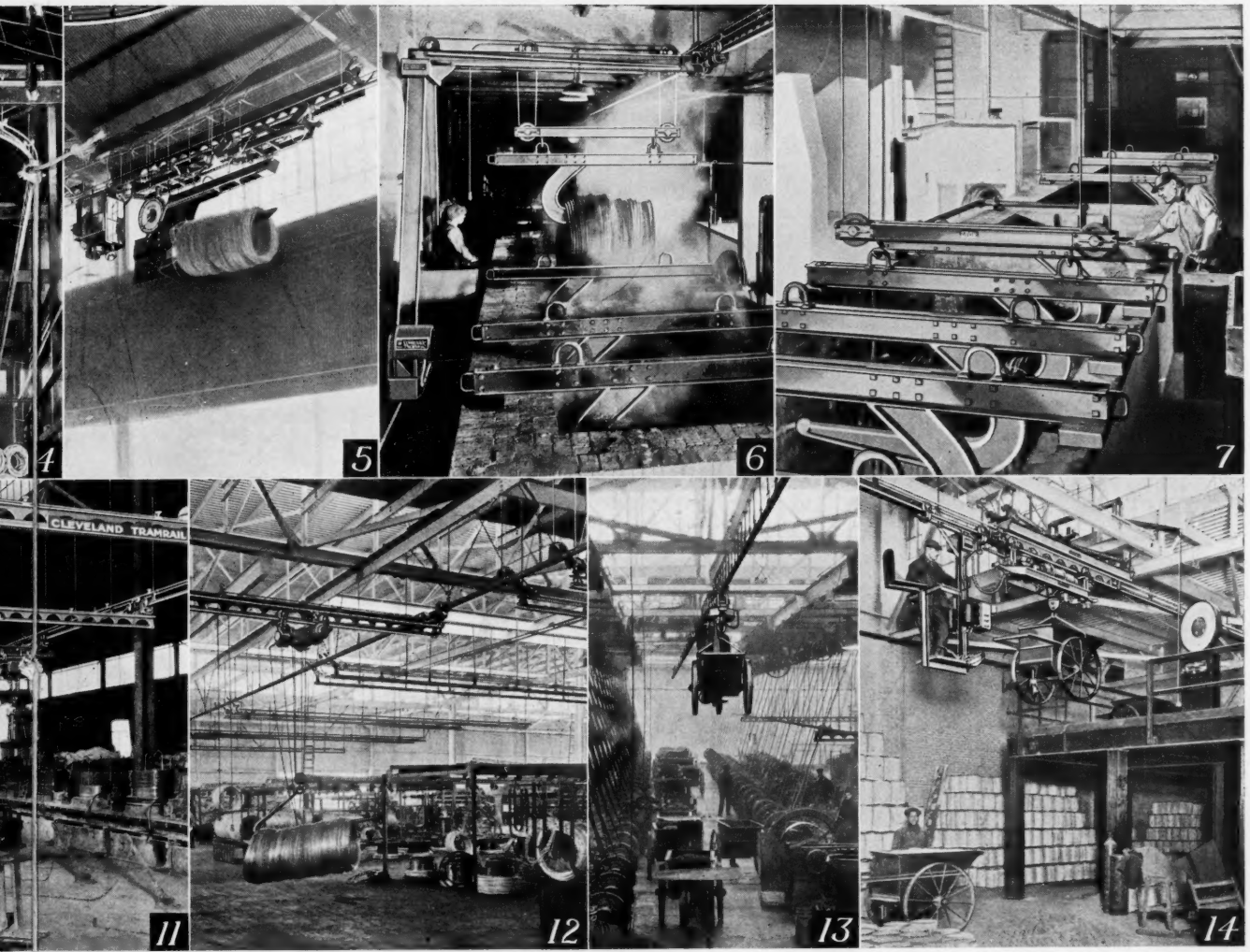

7. The Gantry Crane over the sull rack
8. Pick up enroute to bakers
9. Through the bakers on Hair Pin Hook —no unloading
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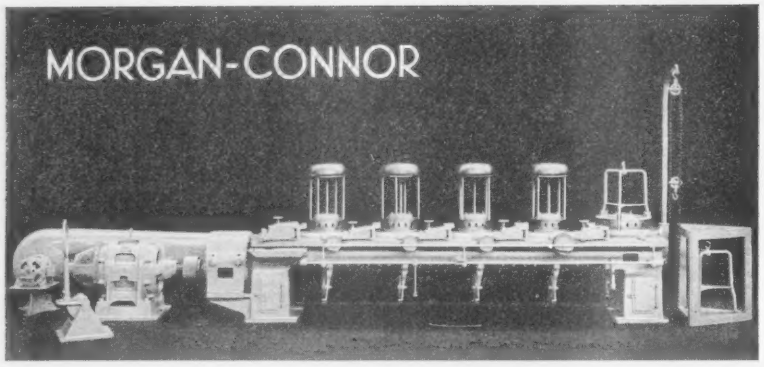

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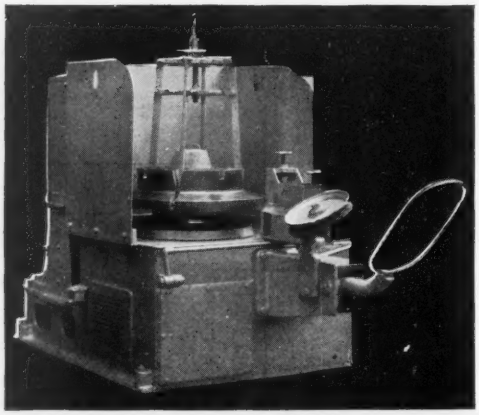

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ing, lime streaks, etc., represent an attempt to find part of the answer to the constant necessity for reducing costs of processing, improvement of quality, and the ever increasing demand for extra bright wire; and it is the results of some of these endeavors that are embodied in the following paragraphs.

✦ ✦ ✦

Experiment On No. 5 S. A. E. 1010-1020 Hot Rolled Rods

IN an attempt to eliminate the excessive corrosion of rods from unburned gases induced during the baking operation, and to obtain an extra bright finish at a minimum of cost, experiment in one instance was carried on No. 5 S. A. E. 1010-1020 hot rolled rods with a silicate of soda-tri sodium phosphate coating solution. In the belief that 5% alkalinity was sure to produce caustic embrittlement, that a 4% strength was still dangerous, the experiment was carried out using a 3% alkalinity solution made up as follows: 42 degree silicate of soda 2% by volume, tri sodium phosphate 3% by weight, balance of solution boiling water. This temperature of solution was chosen for quick and thorough drying of the rods with the consequent elimination of all baking.

✦ ✦ ✦

THE rods were first pickled, rinsed, sull coated, and then immersed in the experimental coating solution for ten to fifteen minutes, after which they were raised above the coating tub and allowed to drip until nearly dry, when they were then put on trucks to finish drying, the time for complete drying averaging five to six minutes. It was found that putting the coated rods on the truck too soon would cause rust spots where the coils came in contact with the truck. However, when treated as described above, considerable improvement over lime coated rods was noticed in the way of non-rusting of the coils during the period they were drying; and, for as long a time as they were under observation, which in most cases was from twenty-four to forty-eight hours, no rust was noted on the coated coils after they had dried.

✦ ✦ ✦

THESE rods were drawn down .035″ on a 28″ diameter block running at a speed of 40 r.p.m. A potassium base soap which had previously been mixed with dried and powdered lime on the basis of one-third pound of lime to one pound of soap was used as the lubricant. Subsequently other experiments were made using a prepared oil lubricant in place of soap.

✦ ✦ ✦

BOTH cast iron and tungsten carbide dies were used on different size blocks and at various speeds ranging from 20 r.p.m. to 70 r.p.m. Each experiment made with the experimental coating and the soap lubricant produced a much brighter wire than it was possible to obtain from a lime coated rod and the same lubricant, while the use of the oil lubricant produced even a brighter finish.

✦ ✦ ✦

HOWEVER, the dies used in these experiments soon started to scratch and their life was materially shortened as compared to the tonnage of lime coated rods which ordinarily could be drawn through them before they had to be replaced, the life of the cast iron dies being 55% to 60%, and that of the tungsten carbide dies 15% to 20% of their average life with lime coated rods.

✦ ✦ ✦

THE opinion was expressed, in connection with the use of a silicate of soda-tri sodium phosphate coating, that a die with a longer neck or entrance and a shorter surface bearing would give longer service than one of standard design; but when this was tried out, it was found that while there was a considerable increase in service obtained over the standard design, it was not sufficient to reduce the die cost to a point where it would compare favorably with the same cost in connection with lime coated rods. This factor plus the difficulty of eliminating hydrogen embrittlement without baking, resulted in the unfavorable decision that this experimental coating could not be used to advantage in place of lime.

✦ ✦ ✦

Experiment On 1-4" And 1-2" S. A. E., 1010-1020 Hot Rolled Bolt Rods

IN another instance experiment was carried out with ¼″ and ½″ S.A.E. 1010-1020 hot rolled bolt rods which were coated with a silicate of soda solution made up by mixing 61 pounds of 42 degree Baume silicate of soda with 8100 pounds of water, for an alkalinity of .75%.

✦ ✦ ✦

THE temperature of this experimental solution was kept at 200 degrees F., and baking of the rods was eliminated. Using only tungsten carbide dies, draws of one and two holes were made, the drafts or "cut" in every case being .035″ or .045″.

✦ ✦ ✦

THREE different types of lubricants were used, a potassium base soap, one of the standard brands of oil lubricant and a standard brand of rod and wire drawing grease; but no material difference could be noticed in the results obtained from any of these three lubricants in so far as brightness of finish and freedom from scratching were concerned.

✦ ✦ ✦

THE experimental solution was kept up to strength by the addition of thirty pounds of silicate of soda each day, and in this same period of time an average of 75,000 pounds of rods were coated. The solution upon becoming old and contaminated with oxide from the rods would commence to turn green and at this point was dumped. With a fresh solution and a new die no trouble was experienced with scratching of the rods, but upon either the solution becoming old or the die becoming worn, scratching would develop, and metal "gaulding to the die" would be encountered. It was further found that when either of the above mentioned factors, i.e. the old solution or the worn die, controlled the operation, scratching and metal "gaulding to the die" would be frequently encountered when taking the second draft on

rods which had been drawn through the first hole without any trouble.

✦ ✦ ✦

FOR the most part, the dies used maintained the same average life as when used in connection with lime coated rods, although they had to be refinished more often. Here again the opinion was expressed that a die with a longer neck and a shorter bearing surface would give longer service than one of standard design, but there is no data available as to whether the suggestion was ever acted upon in this particular experiment.

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BOTH while drying and afterwards, the rods coated with the experimental solution showed less susceptibility to rusting than rods coated with lime, and when drawn had a much brighter finish and a higher polish and sheen than could be obtained with a lime coating. In fact, in this experiment it was found impossible with lime coated rods drawn one hole to duplicate the brightness and finish that was obtained with the experimental coating; and it was also found that with this coating the feeders of the cold heading bolt machines did not tend to become clogged as quickly as would be the case with lime coating.

✦ ✦ ✦

Experiment On No. 5 Rod Using Tri-Sodium Alone

USING tri sodium phosphate alone, an experiment in another case was made on S. A. E. 1010-1020 hot rolled rods, No. 5 size and larger, all of which received a one or two hole draw. The coating solution was made up to 5% by weight and was kept at boiling temperature, and the rods were immersed in this solution for a period of three to four minutes. The experiment also covered the use of a 5% solution made up of equal amounts of tri sodium phosphate and caustic soda.

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THE wire drawn from the rods coated with either of the experimental solutions was lighter in finish and had a higher polish than what could be obtained with a lime coating; and tri sodium phosphate alone gave better results than when mixed with caustic soda. There was no increase in scratching, and the life of the dies was equal to that obtained when a lime coating was used, while the consumption of tri sodium phosphate was approximately fifteen to twenty per cent. of the lime consumption for the same tonnage of material coated.

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THERE apparently was no cause to fear caustic embrittlement with the combination of five per cent. alkalinity, boiling temperature, and three to four minutes immersion; and it was the consensus of opinion that it would require at least twenty minutes immersion before there would be any danger from this embrittlement.

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SMALLER gauges of wire were also included in this experiment, but were found to bind too closely when in coil form to permit self-drying, and rust spots would appear.

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Summary

THERE is no question but what many experiments have been carried on at various times in an endeavor to find a suitable substitute for lime. In so far as silicate of soda and tri sodium phosphate are concerned, this article covers only such work as has come to the personal attention of the writer, from which it would appear that the use of these two products has certain tangible and economic advantages, and certain disadvantages, economic and otherwise. However, are these disadvantages when taken at face value on the basis of experimenting done up to date, of sufficient weight as to warrant the condemnation of these two products without further and more complete investigation?

✦ ✦ ✦

IS there a difference, with the advantage in favor of lime, in the chemical and physical reaction between lime, silicate of soda, tri sodium phosphate and sull coated rods, and between the same products and rods without a sull coat?

✦ ✦ ✦

IS this whole matter of using silicate of soda or tri sodium phosphate in place of lime a question of universal applicability when the baking operation is eliminated from the picture, and a question of economy if the baking operation is included in the picture?

✦ ✦ ✦

IT might be that the answers to these questions lie in just how badly needed are the apparent advantages which have been brought to light in the course of preliminary experiment, and in just how far manufacturers of silicate of soda and tri sodium phosphate will enter into cooperative research with interested mill consumers, the former in an endeavor to develop a potentially large and lucrative outlet for these products, and the latter to obtain an all-around superior coating for wire rod.

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Canadian Copper From The Mine to The Wire User

By D. Horsfall,

Works Manager, Canada Wire & Cable Company, Ltd., Toronto, Ontario, Canada.

An outline of the history and development of Canadian copper, and a description of the electrolytic refining methods followed in Canadian practice together with details of wire drawing processes.

Historical

MOST things start at a definite period; unfortunately, we are unable to trace the first use of one of the more common metals of today, namely "Copper".

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"IT is very probable that the nature and use of metals were not revealed to Adam in his state of innocence; that they were very early discovered is manifest from the Mosaic account of Tubal Cain, who was the first instructor of every artificer in Brass and Iron", —long before the age of instructors is the age of individual experimenters.

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THIS takes us back to the dark indiscernible ages in which man was slowly evolving out of the monkey stage, when he was beginning to learn that one could travel on two legs instead of four.

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VARIOUS excavations in Europe, Asia and the South Eastern Islands give us a chronological table illustrating the slow progress made by man in thousands of centuries.

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HAVING definitely accepted the axiom that there was a start to the use of Copper, we will next move to the relatively later periods when we find the Romans, Greeks and Phoenicians mining Copper in the uncovered deposits of their day in Cyprus, Spain, etc. Their methods are illustrated and described in various treatises on the subject, and for those interested, there is a wealth of information on the subject.

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THESE ancients used Copper for almost every conceivable purpose and their requirements in their own time, ran into large volumes, but modern demands far outweigh the wildest dreams of ancient production.

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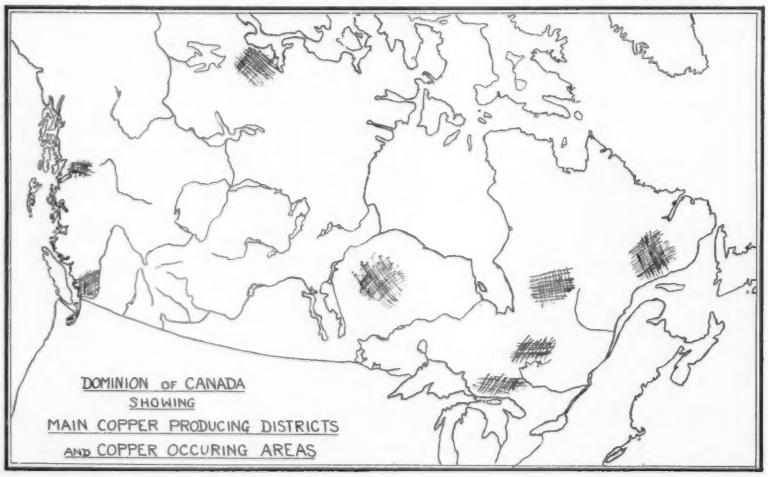
NEARLY fifteen centuries later, Columbus sailed into the open waters of the Atlantic and thereby indirectly opened up a new field of Copper. His exploration was followed by other adventurous spirits, who soon became aware of the richness of the "New Land", which eventually led to the "bonanzas" of the Copper Mines in North America and opened up large ore bodies in the Lake Superior districts such as Calumet & Hecla, and Tamarach; then in the west at Butte, Montana, the rich deposits of Anaconda; in Arizona the Copper Queen, and Mexico with her Cananea. These were the forerunners of the large Canadian Mines and it is at this point we have the beginning of our story in detail.



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THE earliest discovery of Copper in Canada, we are told, was made by Master Simon, a Mining Engineer, who accompanied Champlain to America in 1604. This find of native Copper was reported at Cape d'Or, Nova Scotia. The Jesuit Fathers are reported to have experimented with native Copper at Point Manainse on the north shore of Lake Superior in 1770.

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THE following year, Samuel Hearne, a clerk in the Hudson Bay Trading Company, travelling in the northwest territories, prospected the Copper Mine River area for deposits of Copper Ore.

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THE first mention of Copper Ores in the Eastern Townships, Quebec, was made in a Geological Report dated 1847-8, which was near the site of the future Eustis Copper Mine opened in 1865. At the same time, the Montreal Mining Company began the first real mining operation at Bruce Copper Mines in Ontario. Nearly twelve years later, the Wellington Copper Mine erected a Crushing Plant in Ontario.

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THE next important item in the history of Copper was the

discovery of Copper on the west coast at Howe Sound and Knight Inlet, B. C., in 1864.

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BEGINNING with the discovery of nickel and copper-bearing ores, and operation of the Murray Mine by Thomas Flanagan in 1883, we reach a period when the Sudbury and Copper Cliff areas are born, as far as metal producers are concerned.

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IN rapid succession came numererous mines such as Worthington, Frood, Copper Cliff, Creighton, Stobie, etc.

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IN Copper Cliff, the first smelter was blown in on December 24, 1888; two years later, the first smelter was blown in at the Murray Mine at Sudbury and the matte was shipped to Wales.

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IN 1891 the first shipments from Rossland, B. C., went to Colorado Smelting Works at Butte, Montana.

✦ ✦ ✦

IN 1892, Colonel R. M. Thompson developed the Orford nickel-copper separation process, and Dr. Ludwig Mond developed the Mond copper-nickel separation process. These two processes played their part in the early development of Canadian Metal Products.

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THE Rossland ores which were being processed at Butte, in 1896, were delivered to the B. C. Smelting & Refining Company, which showed the value of the deposits and justification of Canadian processing equipment.

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THREE years later, the Granby Consolidated Mining, Smelting & Power Company was incorporated in British Columbia, which blew in their first smelter the following year.

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AMONG the numerous developments, discoveries and items of historical interest of the first 15 years in the twentieth century are deposits found in British Columbia; Chibaugamau district in Quebec; Flin-Flon in the middle west, and smelting at Garson, Ont., by Mond Nickel Company, and Anyox in B. C. In 1916 we have the International Nickel Company, Incorporated. The first electrolytically refined copper at Trail, B. C. In 1921 the great deposits of ore were discovered at Noranda which eventually produced one of the finest plants on the Continent which began smelting operations and shipping in 1927. In 1930-31 two new electrolytic copper refineries were started, one at Copper Cliff, Ont., and the other at Montreal East.

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Present Day Practices

COPPER is the most important of the non-ferrous base metals, whether considered from the viewpoint of Canadian tonnage mined, the market value or the general economic use to which it is put. There are numerous types of ore from which Copper is produced, but on an average, the amount of Copper contained in the ore is only 2%, consequently, the production of commercially pure copper from these low grade ores is a combination of technical control on process and skill in solving the greatest efficiency of the equipment and types of treatment.

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IT is at this point that we should consider present day practice of mining, smelting and refining.

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Mining

THE mining operation consists of sinking suitable "shafts" usually (but not necessarily) vertically into the ground from which horizontal "crosscuts" are run at various "levels" as a means of general access to the ore bodies. From these "crosscuts" are other traverse cuts known as "drifts".

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CONNECTION between "drifts" on adjacent "levels" is made from time to time by means of "raises". This complicated system of "shafts", "crosscuts", "drifts" and "raises" provides the means by which the ore is transported from the "stope" to the surface. In a large mine it resembles the artery system of the human body and is an intricate system of "highways" and "byways".

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THE "Stope" is the place where the ore is actually removed from the rock.

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THE ore body is drilled and charges of explosive are set and fired. The broken ore is then dropped to the "level" below, loaded in cars and drawn to storage pockets near the shaft by means of electric locomotives. It is then hoisted to the surface by means of skips where it is discharged into crushers which deliver crushed ore capable of passing 3/8" mesh screen.

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Crushing The Ore

AT the crushers, the ore is graded into two types, viz: the high and low grade ores. The low grade goes to the concentrator where it is brought up to the consistency

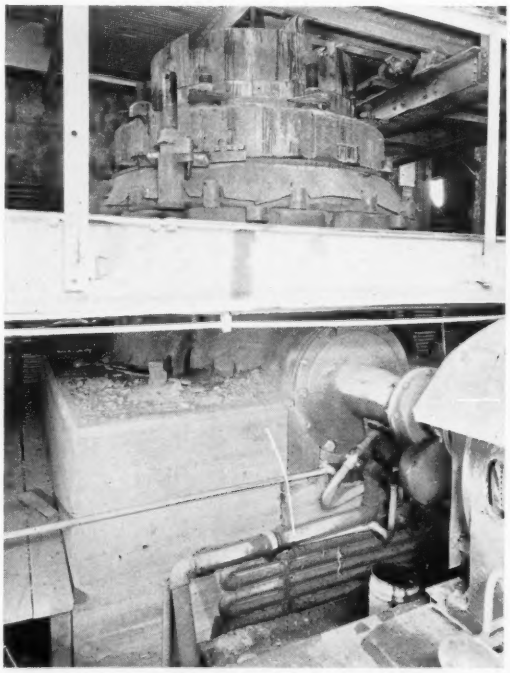

Fig. 1. Typical Cone Crusher.

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of the high grade and delivered to the roaster. This is the first operation of the smelter plant.

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The Smelting Operation

THE roaster essentially is a large spiral tray covered with a relatively thin layer of ore. Here the major portion of the sulphur is burned off. The ore is next delivered to the reverberatory furnaces. This consists of a melting furnace heated by pulverized coal where the ore is melted together with a siliceous flux. The copper and precious metals, still in the form of ore, melt out and remain in the bottom of the furnace. The slag composed of silica and waste rock is drawn off at the top. The product of this process is the Copper Matte and contains approximately 20% Copper, the balance being principally iron and sulphur.

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THE Copper Matte in molten form is introduced into the converter where air is introduced with a powdered siliceous flux to reduce the iron and sulphur content, the flux carries off the iron oxide.

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THE Copper is then poured off in the form of Blister Copper, characterized by the appearance of blisters on the surface due to the escaping gases from the cooling of the metal. Proceeding to the Anode Furnace air is again blown through the molten blister copper. In this process the remainder of the iron and sulphur is removed, but an excess of copper oxide is produced; this in turn is reduced by means of poling, which is the term applied to stirring the molten metal with green wood poles. The copper is now poured into anodes weighing about 700 lbs. suitable for the refinery and consists of 99.5% pure copper.

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The Refining Process

THE refining process consists of hanging the anodes in a suitable tank through which a continuous flow of copper sulphate and sulphuric acid is passing. At the commencement of the operation a thin starting cathode sheet is placed opposite to the anode and a direct current is passed through a series of sets of anodes and cathodes.

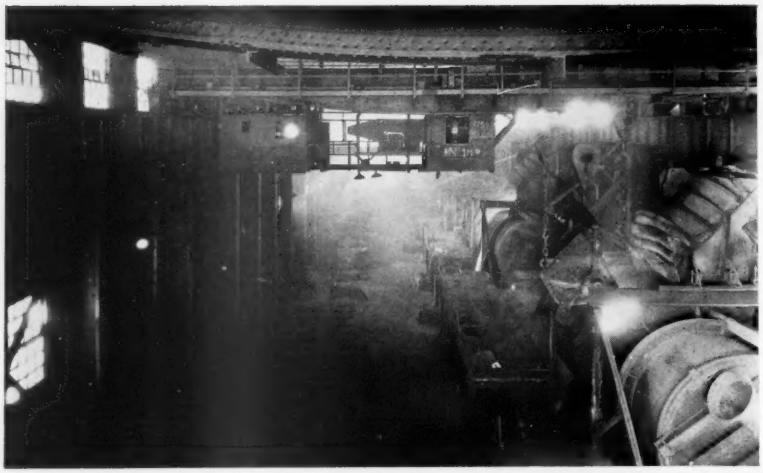

Fig. 2. View of Smelter.

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THE Copper is dissolved from the anode and deposited on the cathode as extremely pure copper. The precious metals are not transposed to this new sheet, but settle in the tanks as slime being refined in a precious metal refinery. The cathodes are now re-melted in a wire bar furnace and poling is again necessary to control the percentage of Copper Oxide; the metal is poured into moulds of various shapes and sizes and the products are known as wire bars, billets, ingots and cakes or slabs.

IT should be remembered that all Copper is not electrolytically refined, but this paper deals particularly with Canadian production methods, hence the above description, as all Copper in Canada is produced in this manner.

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TO this point, we have been dealing only with the refined copper and it is necessary to stress that the further conversion of Copper began, considering only rods, in 1922, when a Rod Mill was installed at Brockville, Ont., by The Eugene F. Phillips Electrical Works Limited. This was followed by a modern mill being erected at Montreal East by the Canada Wire & Cable Company Limited, which necessitated the Phillips' mill being discarded. A year after, a new up-to-date mill was erected at Brockville.

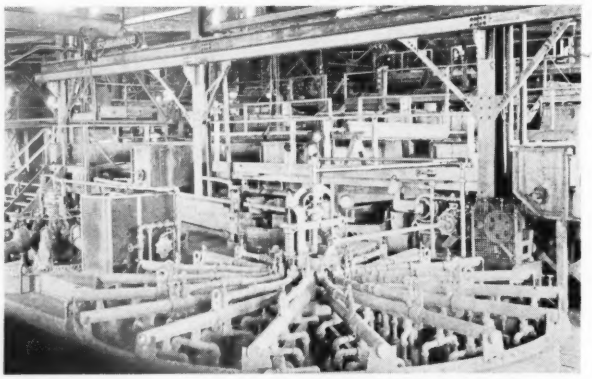

Fig. 3. Gentner Thickener.

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Copper For Wire

AT this point, we enter the field of the Wire Manufacturer, and it is generally acknowledged that the first operation in his field is the rolling of Copper in the Rod Mill. The principle of any Rod Mill is squeezing the bar, which was produced by the Refinery, between several pairs of notched steel or chilled iron rolls, so as to reduce its cross-section at each pass or pair of rolls, and at the same time, by alternating the section of the stock from flat to square or oval to rectangle work the metal in a definitely planned scheme to develop the best grain structure possible. Like most metals, proper working is essential to bring out the best mechanical characteristics of Copper.

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THE first point in any Rod Mill is the proper means of receiving and storing Copper Wire Bars and the reclaim of same to feed the billet furnace.

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The Billet Furnace

THE billet furnace is for the purpose of heating to the required temperature the wire bars before passing to the roughing mill. The bars are heated to temperatures varying from 1600° to 1800° F. depending upon the mill, and are discharged from the opposite end to which they are fed into the furnace, on to a furnace table or some other mechanical arrangement to deliver the bar to the roughing mill.

The Roughing Mill

THERE are several types of roughing mills, all essentially the same, but differing only in the passage arrangement of rolls, housings, etc. The general tendency in new up-to-date equipment is a five or six pass three high automatic mechanically fed mill. During this phase, the rod is handled completely by machinery as it passes backwards and forwards through the rolls.

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Intermediate and Finishing Mills

AFTER the roughing mill are the intermediate and finishing mills which consist of a series of stands located side by side, each having two rolls through which the rod passes in its process of reduction. It is customary to have on one side of these mills, mechanical equipment to handle the rod and return it to the feeding side. This equipment is a channel, or commonly called a "repeater". The other side is manned by "stickers". The operation of "sticking", particularly on the finishing mill, is a treat to watch and is probably one of the most fascinating operations in the whole copper industry.

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AT first view, it appears ridiculously easy, but this impression is gained from the perfect timing and grace of swing as the sticker utilizes the momentum of the rod to help enter the end between the next pair of rolls.

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Pickling

AS the rod emerges from the finishing rolls or stand, it is fed through a pipe into a coiler which is revolving at a speed sufficient to take up the rod as it is delivered. The rod is still hot at this point, and on cooling, forms a black copper oxide. For shipments being made where exposed to salt air, this oxide is usually left on the rod, but for local use, it is taken off in the pickling tanks which are a part of the Rod Mill.

THESE pickling tanks are used as containers of sulphuric acid, water, etc., to be used for cleaning rods after which it is customary to remove the rods and immerse in a tank of hot water to ensure drying.

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Wire Drawing

THE next step,—Wire Drawing —is one of those arts which, to trace the beginning is impossible, but cuts and written descriptions of methods employed in the middle ages do not differ in principle from modern methods. The end of the rod is tapered and threaded into a circular orifice smaller than the original wire and the wire is pulled through the hole; the results are, smaller diameter, longer length, harder material. The

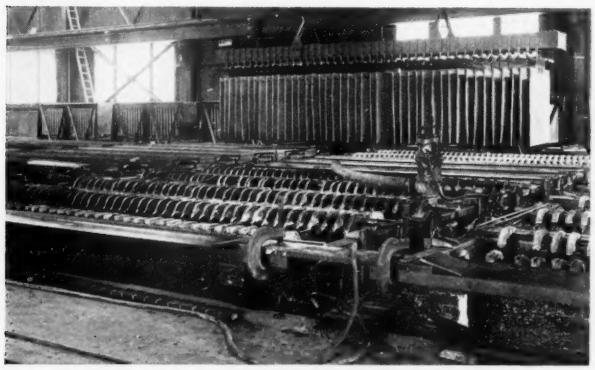

Fig. 4. Suspended by the crane is a load of cathodes from one of the tanks beneath. In the foreground are the massive bus-bars that feed the individual plates in the cells and a connecting link clamped to disconnect two units by short circuiting them. ✦ ✦ ✦ ✦

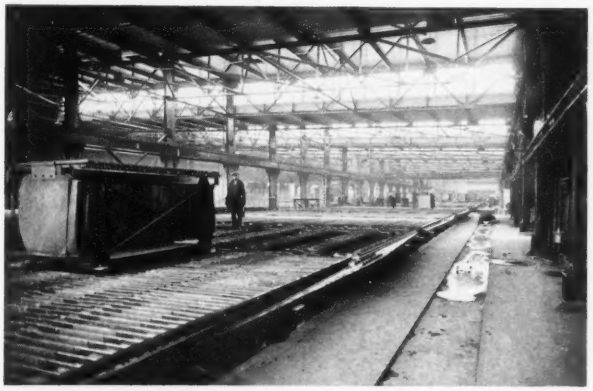

Fig. 5. View of tank house looking North. Rack with starting sheets in left foreground. Note the floor level only a little below the tops of the tanks to facilitate inspection and access to the tops of the tanks. The bus bars are shown as well. Those at the other side of the tanks where the current is introduced are rectangular—not tapered like these. ✦

orifice or die is usually made from a piece of steel plate, chilled iron, alloy, or in the case of fine wire, a diamond. Wire Drawing Machines may incorporate a single reduction or multiple as high as twenty-four dies in the single machine. Table A shows the standard practice employed in a large number of plants.

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THE process of drawing wire tempers the copper and renders it much harder and less ductile than in its original state, and at certain processing intervals, it is necessary to anneal the wire. This is done by heating the copper in a chamber which excludes air to any required temperature. The temperatures vary with the time of annealing, but commercial practice seems to be on large wire about 900-1000°F.

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FROM the time the wire leaves the Drawing Department there is no fixed sequence. However, in general, for rubber covered wire, the annealed bare wire is tinned and goes directly to the Rubber Covering Department, or intermediately to the Stranding or Bunching Departments. For Lead Covered Paper Insulated Cables, the wire goes to Stranding, Paper Insulating, Impregnating and Lead Departments.

✦ ✦ ✦

Fields Served By Wire Industry

THE fields served by the wire industry are innumerable, but a few of the extremes are the large Power Plants and Transmission Lines, Hair Curler Wire, Large Cables for Mines, Oil Wells, Underground Transmission Cables and Radio Wire, etc. As Samuel Crowther once said, in dealing with copper as a subject for a paper in the "World's Work", — "Copper is one of those basic commodities the world cannot do without and the only field in which copper is today supreme is one that the ancients never even heard of—'Electricity' ".

✦ ✦ ✦

THE figures given below outline Canada's growth in the copper industry, showing the relationship of her production against world production.

TABLE A

Machine	From	To
Draw Benches	1″ to ¼″ Rods	.100″ Wire & Inter. Sizes
Heavy Draw. Mach.	⅜″ Rods to .100″	.064″ Wire & Inter. Sizes
Interm. Draw. Mach.	,128″ — .100″ wire	.015″ Wire & Inter. Sizes
Fine Wire Draw. Mach.	.035″ — .010″ wire	.001″ Wire & Inter. Sizes

✦ ✦ ✦

Summary

IN summing up the resources of Canada as a potential world leader in production from the ore, we see vast territories unprospected, and miles upon miles of virgin country untouched by man in his present state of mental development. Who can say what untold fortunes lie waiting for some prospector's hammer. It is enough to say that even the most sceptical and pessimistic Mining Engineers and Bankers who have investigated the present fringe of mines around an unquestionable land of mineral resources predict a brilliant future for Canada. The Pre-Cambrian shield covered over two million square miles and the outstanding feature of Canadian Geology is the vast area underlying the formations of Pre-Cambrian age. It is anticipated that Canada will occupy the same position in regard to world trade in minerals as the United States does in Petroleum industry at present. Canada's major minerals are gold, copper, silver, coal, nickel, lead, zinc and asbestos and a few of her smaller produced minerals include gypsum, lime, iron, cobalt, feldspar, fire clay, cadmium, cement, bismuth, arsenic, platinum, palladium, sulphur, salenium and tellurium.

(*Please turn to page 353*)

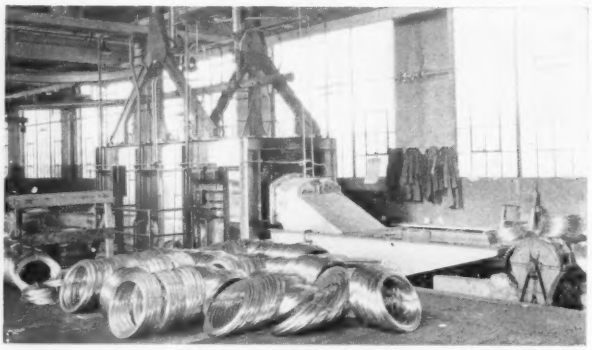

Fig. 6. View of Oil Fired Annealing Furnace.

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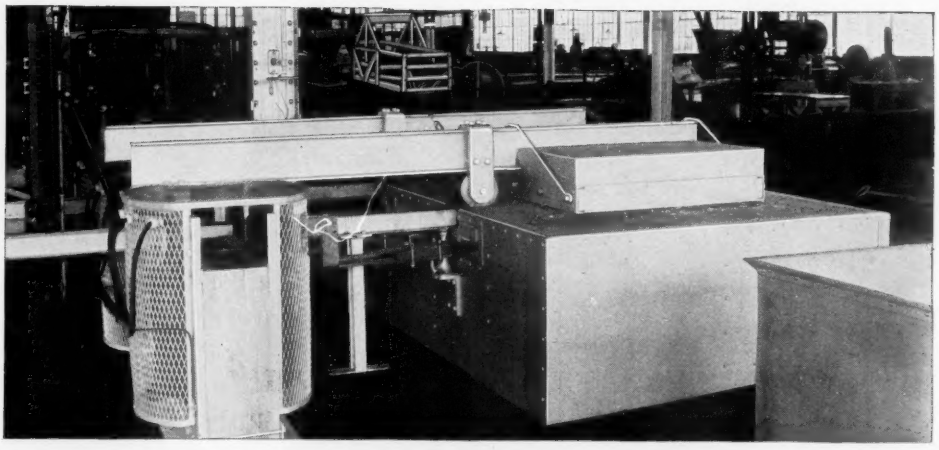
ESTIMATED WORLD TOTAL PRODUCTION BEFORE 1800 DID NOT EXCEED 1,000,000 TONS

Year	Canada	World	% of World Production
1895	5,800	332,182	1.75
1900	10,400	486,600	2.14
1905	22,815	689,784	3.3
1910	26,350	861,109	3.06
1915	46,456	1,050,276	4.42
1927	35,613	1,682,361	2.12
1929	124,060	2,127,834	5.83
1930	151,737	1,749,598	8.68
1931	146,152	1,501,486	9.73
Oct. 1933	14,870	97,000	15.32

BELLIS FURNACE *on the Job*

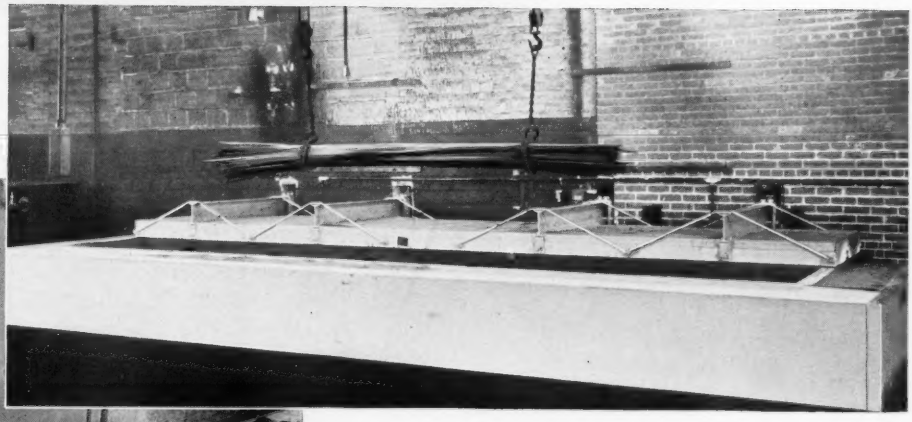


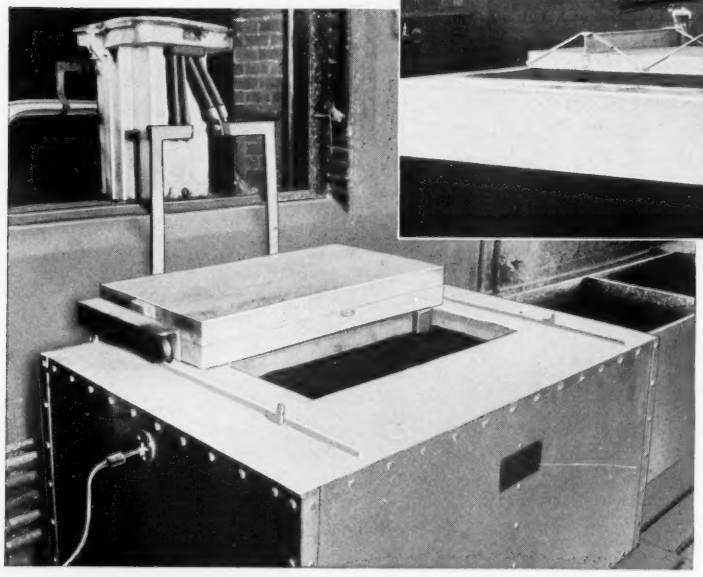
ANNEALING SHEETS AND STRIP:

Cold rolled strip from the rolls near the furnace are bright annealed in 15 minutes and are back for re-rolling.

ANNEALING WIRE:

BELOW—*Wire of steel, brass, nickel, copper, gold and silver are uniformly bright annealed in minutes instead of hours in this* BELLIS *Furnace.*





ANNEALING TUBES:

Thin walled tubes in lengths up to twenty-five feet and charges of one thousand pounds are bright annealed in ten minutes per charge in this Furnace.

BELLIS

The New Method of Annealing

THE BELLIS HEAT TREATING CO. - - BRANFORD, CONN.

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1. Quantities of each kind of metal you anneal .....
2. Hour when off-peak current can be used .....
3. Unit cost of off-peak power .....
4. Average cost per unit of power .....
5. Your old cost of annealing with electricity .....
6. Your cost of annealing with the New Method .....
7. Saving to you .....

You fill in lines 1 to 5 and mail to us. We'll do the rest. Don't fail to see this New Furnace on the job at Booth 460 at the STEEL SHOW October 1-5.

Smelting, Casting and Rolling of Electrolytic Copper

By

Roy H. Miller
Asst. Supt. of Refineries, Anaconda Copper Mining Co.
Great Falls, Montana

and

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The authors have attempted to describe the present day practices which are followed in smelting, casting and rolling of electrolytic copper. An attempt has been made to describe the processes in a concise and simple manner so that the article may be easily read by anyone who is not acquainted with the technical details of the operations.

AS found in nature, copper is most generally combined with one or more other elements, and by far the greatest percentage of copper produced in recent years has come from ores containing copper in some form of combination with sulphur. Frequently these copper minerals contain not only copper and sulphur but also contain iron, arsenic, antimony, nickel and other metals, and, in some cases, contain appreciable amounts of silver and gold. The ores of copper contain not only the copper minerals but also contain certain gangue minerals which usually are separated from the copper minerals and are discarded before smelting operations begin.

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Concentration or Milling

THE operation of separating the valuable minerals from the gangue constituents of the ore is known as concentration, or milling. As much of the valuable mineral occurs in very small particles disseminated throughout the ore mass, it is necessary not only to crush the ore but also to grind it to extreme fineness in order to free all mineral particles from the gangue material. Crushing and grinding are usually wet operations. Formerly, the separation of valuable minerals from gangue minerals was accomplished by utilization of their differences in specific gravity but in recent years this has been accomplished largely by the flotation process, wherein the finely ground ore pulp is mixed with small quanities of oils and chemicals and the mixture subjected to violent agitation, producing a froth. The valuable mineral particles adhere to the froth bubbles and rise to the surface of the pulp and are skimmed off, or overflow the container, while the non-adhering or gangue particles are drawn off from the bottom of the container and are discarded. The mineral particles are collected and filtered as "concentrate". While the usual copper ore contains only from 1 to 5% copper, the concentrates vary from 20 to 40% copper.

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Smelting

THE concentrate is usually roasted to remove a part of its sulphur and the resulting calcine is smelted with proper mixture of fluxing materials in a reverberatory furnace. In this operation, part of the iron and nearly all of the remaining silica, alumina, lime, etc., combine to form slag which is skimmed off and sent to waste while the copper and remaining sulphur and iron combine to form "matte", which, being heavier than the slag, accumulates in the bottom of the furnace. Matte is tapped from the furnace at intervals and is sent to a converter where air is blown through it to remove the sulphur. The sulphur combined with iron burns off first, freeing the iron to form slag which is skimmed off leaving behind the molten copper sulphide. Continua-

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tion of the blowing operation removes the remaining sulphur leaving molten copper in the converter. The copper is transferred to a casting furnace where it is given a partial refining to remove remaining sulphur and is finally cast into "anodes", weighing from 400 to 800 pounds, and is transferred to an electrolytic refinery for final refining.

Plant of Anaconda Wire and Cable Co., Great Falls, Montana.

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SILVER, gold, nickel, selenium, tellurium, arsenic, antimony, and other metals, in whole or in part, follow copper through the concentration and smelting operations and remain in the converter copper as cast in anodes, the anodes usually containing only from 99 to 99.50% copper. Copper in this form is too brittle for rolling into rods or sheets and is also of too low conductivity for electrical uses.

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Refining

THE anodes are hung in refining tanks through which is circulated an acid solution containing sulphuric acid and copper sulphate. Between the anodes are hung thin sheets of pure copper, or "cathodes". Direct electric current is passed from the anode, through the solution, to the cathode and in so doing transfers pure copper from the anode and deposits it on the cathode sheet, building up the cathode as the anode is corroded. Impurities in the anode either pass into the circulating solution or settle into the bottom of the tank.

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THE principles involved in the melting of electrolytic copper and the casting of it into the regular horizontally cast wirebar are generally the same at all refineries. The main differences are in the types of equipment in use and the methods employed in handling the various supplies and materials used in connection with the operation.

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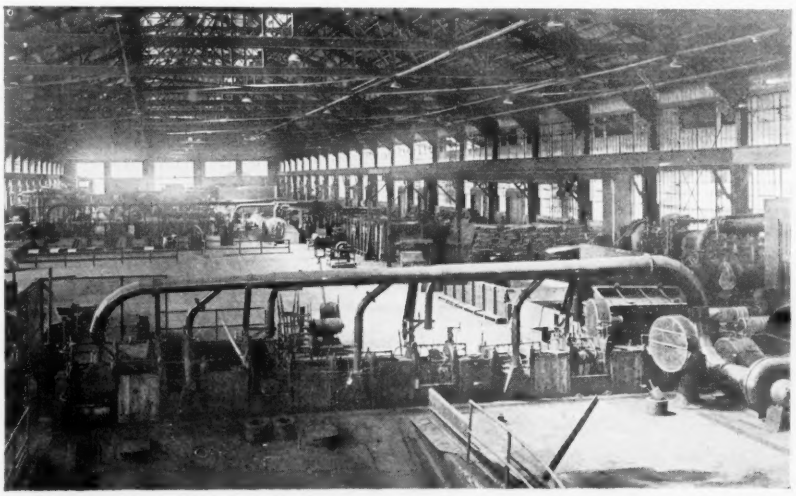
Refined Electrolytic Copper

CATHODE copper as it comes from the electrolytic refinery is very pure, containing 99.98+% copper, no oxygen, and the electrical conductivity is very high—101+% I.A.C.S.* However, before it can be shipped to the consumer it must be melted and cast into shapes suitable for the mills. This would seem to be an easy proposition; but, copper when molten readily absorbs gasses. During the melting period it absorbs such gasses as hydrogen, carbon monoxide, sulphur compounds and others, all of which are products of combustion of the fuel and which pass over the copper as it is being melted and while it is in the molten state. Were the metal to be cast in this condition it would be impossible to make good sound castings, so the melting process really becomes a refining process, getting rid of the absorbed gasses to the extent that sound castings high in electrical conductivity can be made. This copper is not as pure as the original cathode, nor does it have as high an electrical conductivity because in the ordinary process of refining, due to the fact that all the sulphur absorbed is not expelled and oxygen is introduced into the metal, the cast copper is lower in copper content and for the same reason lower in electrical conductivity than the cathode copper from which it



Interior view rolling mills, Anaconda Wire and Cable Co., Great Falls, Mont.

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* I.A.C.S.=International Annealed Copper Standard at 20%.

is produced. A representative analysis of refined electrolytic copper would be as follows:

	Per Cent
Copper	99.959
Oxygen	.030
Zinc	.0004
Lead	.0006
Silver and Gold	.0010
Arsenic	.0015
Antimony	.0015
Nickel	.0015
Selenium	.0002
Tellurium	.0008
Sulphur	.0015
Iron	.0020

Conductivity I.A.C.S. 100.60 to 100.80.

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Necessity for Oxidation

TO accomplish the elimination of the absorbed gasses, it is necessary to oxidize the copper while molten until it contains 6 to 7% cuprous oxide. In the presence of this amount of cuprous oxide the gasses are not soluble and any that might have been absorbed are expelled.

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WHEN this point is reached the copper is known as "dry" or "set" copper. Upon solidification it sets with a concave surface with a large shrink-hole under the surface. It has a dull brick-red color and can be easily broken. It is impossible to draw a wire from this copper.

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AFTER the copper has been oxidized to this point with cuprous oxide and all furnace gasses, and particularly sulphur[1] have been expelled, it is necessary to reduce the cuprous oxide to metallic copper. During this operation the utmost care is taken to prevent the re-absorption of gasses. The fuel and all other materials used should be very low in sulphur. The reduction is carried on until the copper contains from .02 to .05% oxygen and is known as "tough pitch" copper. This copper upon solidification sets with a flat or slightly convex surface free from shrink holes. It has a fine grain, salmon pink color, and is very tough. It is now ready to cast and should be removed from the furnace while in this condition.

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Reverberatory Furnaces for Melting

THE melting operation is carried on in reverberatory type furnaces of 250 to 325 tons capacity. These furnaces have air cooled bottoms from 18 to 32 inches thick made of silica brick or silica sand fused in place. The side walls, 13 to 18 inches thick, are of magnesite brick from the bottom to a little about the metal line; the balance of the side walls and the roof of 12 to 20 inches thickness are of silica brick. The side wall brick are backed with clay brick for insulating purposes. The whole furnace to above the metal line is surrounded with side plates held in place against the side walls and ends with large vertical H or I beams with cross and longitudinal tie rods both at the top and bottom of the furnace.

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THESE furnaces are usually provided with waste heat boilers of 300 to 400 B. H. P. capacity.

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ONE side of the furnace, known as the charging side, is equipped with large easily removable doors through which the cathode copper can be charged into the furnace. These doors, the bottoms of which are several inches above the metal line and reach almost to the roof, are large iron frames filled with brick. At the "verb" end of the furnace is a door about 36 inches square known as the poling door. The poling or reducing operation and skimming are done through this door.

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AT the opposite end of the furnace is the burner installation for burning pulverized coal, fuel oil or natural gas[2]. The side of the furnace opposite the charging side; that is, the casting side, is a solid wall excepting at the tap hole which is located at the "verb" end of the furnace. The tap hole is a vertical slot 30 to 36" long and about 5" wide at the outside and about 9" wide at the inside, extending to the bottom of the furnace.

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THE furnaces are served by charging cranes located at the charging side of the furnace. These cranes are capable of picking up piles of cathodes weighing up to 7,000 pounds and placing them in the furnace. Cathodes are delivered to the furnace on industrial cars on a track running close alongside of the furnace on the charging floor, making the cathodes easily accessible for charging into the furnace.

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FIGURE 1 shows the dimensions of one of the copper furnaces at the Great Falls Reduction Department of the Anaconda Copper Mining Company.

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AT the casting side of the furnace and at a lower elevation than the charging floor is located the casting machine, mould presses, and all other necessary apparatus used in handling the product.

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The Casting Machine and the Mold Presses

THE casting machine is a heavy circular machine 40 to 50 feet in diameter supported on rollers. It revolves around a stationary spindle. It is electrically operated with suitable control devices for starting and stopping. The moulds, made of copper, are mounted around the outer edge of the machine.

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AT the edge of the machine next to the furnace are located the ladles and the equipment for operating the ladles. A short launder extends from the furnace at the tap hole to the ladles. The ladles are large cast iron spoon-shaped shells lined with brick and a sand cement mixture. Across the ladles about a foot from the pouring edge and about 1½" above the bottom is a skimming bridge made of brick. This acts as a skimmer, as

all of the metal when poured from the ladle into the moulds has to pass beneath this bridge. The bottom of the bridge is always submerged in the liquid metal so it prevents charcoal or other foreign material from following the stream of metal as it flows from the ladle into the mould. The pouring end of the ladle is so arranged that the same amount of metal can be poured into several mould pockets at the same time. The ladle is operated by holding the pouring end stationary and raising or lowering the back end.

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Material Handling

AT the opposite side of the casting wheel from the furnace, or ladles, and directly under the wheel is the bosh. It is a large watertight tank. Across the bottom of the bosh and along an incline to the floor level is an endless conveyor for conveying the copper out of the bosh. Directly over the bosh is the dumping mechanism for turning the moulds upside-down. At this section of the machine is located the water sprays for cooling the moulds. Beyond the bosh and toward the ladles is the righting device for righting the moulds, and also the mould painting equipment. To one side of the machine are the mould presses and equipment for making the copper moulds. This entire equipment and floor space, known as the casting floor, is served by large overhead cranes.

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Complete Furnace Cycle

WHEN a furnace is in operation a complete cycle comprising the operations of charging, melting, oxidizing, reducing or poling, and casting requires about 24 hours.

FOLLOWING is an outline of these operations:

Charging--2 Hours

WHEN the furnace has been tapped dry the tap-hole is filled with tap-hole clay, a wet mixture of fire clay, silica sand and coal screened through 3/8" mesh. The doors on the charging side are opened; the cathodes are brought alongside the furnace and the charging crane lifts the piles of cathodes from the cars, thrusts them into the furnace and piles them in such a manner that the maximum amount may be put into the furnace. During the charging operation as much fire is carried as is possible without interfering with the charging. It often happens that the amount of metal for the charge was not put into the furnace during the first charging operation. In such a case the furnace is opened up after several hours of melting and the balance of the copper charged in.

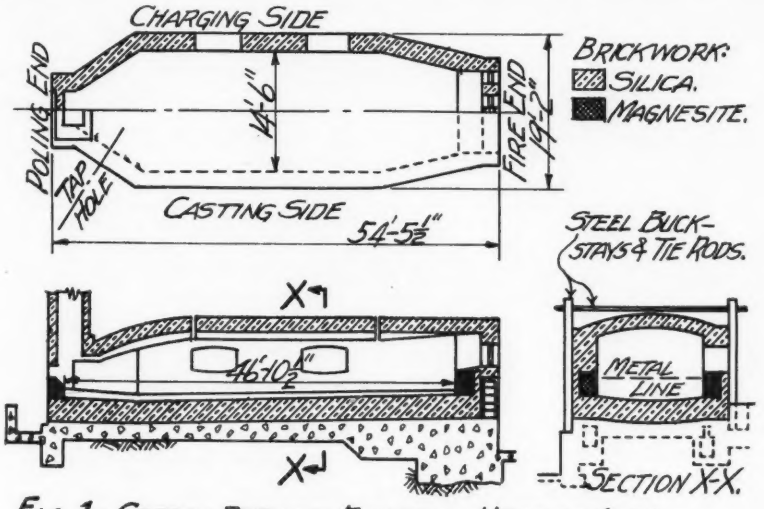

FIG. 1- COPPER REFINING FURNACE; HEARTH AREA 600 SQ. FT.; CAPACITY 300 TONS.

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Melting--13 Hours

AS soon as the furnace is charged the doors are closed, luted and the fire increased As the furnace temperature increases more fire is added until the maximum melting temperature is obtained, care being taken at all times to keep the furnace atmosphere slightly on the oxidizing side as this prevents the absorption of an excessive amount of reducing gasses and has the copper in better condition for the oxidizing period.

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AS the charge is melting it melts from the top down. The copper on the bottom of the furnace is the last to become molten. To hasten the melting of this copper on the bottom, as soon as there is enough hot liquid metal, or about the time the charge becomes flat, an air pipe through which air is blown is inserted through an opening in the side door and thrust into the metal. This agitates the bath and brings the hotter liquid copper which is on top in contact with the solid material on the bottom and thus shortens the melting period.

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AS the copper becomes liquid at the bottom a violent boiling action takes place and continues until all of the copper is melted and all of the slag, coke and charcoal which remained on the bottom after tapping out the previous charge has been brought to the surface. When this boiling action stops the charge has been boiled off and the operator knows that the bottom of the furnace is clean and free from any foreign material or unmelted copper and that it is safe to continue with the refining operation.

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DURING the melting period, as the slag and other foreign material such as bricks, charcoal and coke comes to the surface of the bath, it is skimmed off through the poling door. After the metal has boiled it rapidly picks up heat.

When sufficiently hot (about 2150° F.) it is skimmed perfectly clean and is ready to be oxidized. About 13 hours is required from the time the furnace is charged until the copper has melted and is ready to oxidize.

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Oxidation--3 Hours

THE charge being ready to oxidize, the fire is reduced, or for a period of time may be entirely cut off. Several ½" to ¾" iron pipes through which about 20-pound air is blown are inserted through openings in the charging side of the furnace and thrust into the molten bath. This agitates quite violently the entire bath of metal and completely mixes the cuprous oxide which is readily formed over the entire surface of the bath as the metal comes in contact with the air or highly oxidizing atmosphere of the furnace. Flapping, or splashing the copper with skimming rabble through the poling door is done at the same time to help shorten the oxidizing period.

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OXIDATION is continued until the entire bath contains 6 to 7% cuprous oxide.

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TO determine the stage of oxidation the furnaceman dips from the furnace from time to time a small ladle (about 1½" diameter and ⅜" deep) of copper. This copper he allows to solidify in the ladle. He then breaks the button in two and can tell, both by the way the copper solidifies and by the structure of the button after being broken, when the charge has been sufficiently oxidized.

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Reducing or Poling--2 Hours

AS soon as oxidation is completed the bath is covered with a very low sulphur coke (1% sulphur, or less) or charcoal. All openings into the furnace except the poling door are closed and luted. The fire is adjusted so as to give a neutral or slightly reducing atmosphere and still deliver enough heat to maintain the copper at the proper temperature for casting. This temperature is 2010 to 2025° F. The charge is then poled up to tough pitch. Poling is accomplished by thrusting large poles part way into the furnace through the poling door and forcing the ends in the furnace down into the metal by holding the pole with a bar to chain at the poling door and pulling up on the other end with a chain block.

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THE dry distillation of the wood causes a violent agitation of the metal and a rapid reduction of cuprous oxide. The coke or charcoal cover prevents any re-oxidation and assists in the reduction of the cuprous oxide. As the reduction action continues the physical properties of the metal rapidly improve until the point of level set, tough pitch copper is reached. Continued poling would carry the copper to an overpoled (3 and 4) or spew condition, which would make it unsuitable for castings into sound commercial shapes. If a charge is overpoled it is necessary to repeat the oxidation and poling operations.

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WHEN the copper has been reduced to tough pitch, carrying .02 to .05% oxygen, it is ready to cast and has the best physical properties obtainable under these refining conditions.

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DURING the poling operation the refiner takes test buttons. According to the way these test buttons solidify he is able to tell when the copper has been poled up to the proper pitch. Test bars measuring about 4" x 4" x 8" are also made at the last part of the poling period to make sure the charge is poled to the proper pitch; that is, these test bars should set with level to slightly crown surface.

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IN table A are shown some results showing the change the copper undergoes during the furnace cycle.

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Casting--4 Hours

BY the time the poling operation has been completed the launders and ladles have been lined and heated; the moulds have been leveled, cleaned and dressed; the mould paint, a mixture of very finely ground bone ash and water, has been prepared, and all casting equipment is in readiness for casting.

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THE tapper then starts tapping the furnace by cutting out the tap hole, starting at the top and cutting down as the metal in the furnace is lowered.

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THE metal flows through a launder into the ladles. When the ladles have been sufficiently filled the ladle operators move the casting wheel until moulds are directly under the pouring end of the ladle. They then fill the moulds by raising the back end of the ladle. When the mould are filled the ladle is lowered and the wheel moved until the next empty moulds come into position under the ladle when the pouring operation is repeated and so on. During the casting period metal is taken to the mould presses where moulds are made. The moulds are made by filling a box of the desired shape of the mould with molten copper and immersing the water-cooled copper cores to the desired depth into the copper, letting them remain until the copper has solidified when they are withdrawn. Each mould has 3 to 5 wirebar pockets.

Table A.

	Oxygen %	Sulphur %	Specific Gravity	Conductivity I.A.C.S.%
Cathode	Nil	Nil	8.89	101.60
End of Melting Period	0.16	.0046	8.75	
End of Oxidizing Period	0.60	.0007	8.48	
End of Reducing Period	0.03	.0014	8.60	100.80

IN the course of the revolution of the wheel the moulds are dumped, cooled, righted, painted and returned to the ladles.

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DURING the entire casting operation the utmost care must be exercised to avoid making defective castings. The refiner keeps very close watch of the furnace and the metal to keep the metal at the proper pitch and temperature. He sees that the launders and ladles are kept properly covered with charcoal to prevent excessive oxidation.

Charging furnaces, Anaconda Copper Mining Co., Great Falls, Mont.

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THE ladle and wheel operators spot the wheel in the exact position so that the mould pockets are exactly under the ladle lips, pour the metal at the proper rate, not too slow or too fast, and are careful not to move the wheel too soon after a pour is made.

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THE wheel man takes care of cooling the moulds to the proper temperature and sees that they are always level and in good condition.

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THE painter paints the moulds by spraying the bone ash emulsion evenly over the mould pockets. He must keep his paint to the right consistency and operate his spray so as to give the moulds a uniform coating.

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CARELESSNESS in any of these operations will cause defective castings that are unsuitable for the mill and will have to be charged back into the furnace with the cathodes.

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THE bars as they are dumped from the mould fall into the bosh of water onto the endless conveyor on which they are conveyed out of the bosh. They are immediately inspected. The bars that pass inspection are ready for shipment; rejected bars are returned to the furnace and remelted.

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Common Shapes

COMMON shapes required from the Furnace Refinery are wirebars for the wire drawing industry, slabs and square cakes, including wedge and circular cakes for sheet rolling, ingots to be used for alloys and billets of all sizes for the manufacture of seamless copper tubing, rods and bars. The most popular form of refined copper is the wirebar which is cast in several dimensions and weights with average length of about 54 inches and 4 by 4 inch cross section, weighing from 135 pounds to well above 400 pounds. The 225 to 300 pound sizes are probably the most favored for process wire drawing. Wirebars are cast with pointed ends to facilitate their entrance into the first pass of the rolling mill. Good quality wire rods can only be made from satisfactorily cast wirebar of well refined copper A tough pitch copper with a fine even set is most desirable for all rolling. End-poured wirebars are also coming into demand for special purposes such as strip, bus bar and commutator stock.

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Hot Rolling of Copper

HOT rolling of copper is similar to that of steel, aluminum, brass and other alloys, the chief difference being in the temperature of rolling and the percentage reductions which are made. The material of which the rolls are made also may vary for different metals rolled.

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THE wirebars arriving at the rolling mill are charged in a continuous push-through type reverberatory furnace approximately 45 feet long by 9 feet wide. The furnace is usually fired from the discharge end using either oil or gas. The bars, while being heated, travel the length of the furnace, riding on water cooled extra heavy pipe or special alloy steel skids which are elevated above the furnace floor 10 or 12 inches to permit a portion of the heating to take place below the bars as well as from above. About 120 bars are in the furnace at all times.

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THE temperature of firing is regulated by the speed of rolling which determines the time the bars are in the furnace. Too short a furnace for a given production requires heating at a temperature close to the melting point of copper and is hard to regulate, as any letup in rolling operations may result in dripping ends, or bars sticking together.

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BEST rolling results for most of the common brands of wirebars are obtained at a temperature around 1750° F. At this temperature the bars are taken out of the furnace and given 5 passes in a 2-stand 3-high roughing mill, the common diameters of these rolls being 18″, 20″ or 22″. In this mill the area of the bar is reduced from 4 by 4 or 16 square inches to about .6 of a square inch or 96% reduction of the original area and

the stock is increased in length proportionately. The usual passes in the roughing mill average 50% reduction in area, the maximum for any one pass being 60 to 65%. From these standard rolls the stock is steered over to the intermediate and finishing mills 50 odd feet ahead where nine more passes or reductions are ordinarily required to finish a 5/16" rod. The stands in these mills are also 3 rolls high. The rolls vary from 10" to 13½ or 14" in diameter. The reductions made in the intermediate mill are approximately 20 to 25% while only 10 to 15% is made in the finishing mill passes, this being almost wholly a shaping operation. The usual finishing speed is from 1250 to 1500 feet per minute, the latter being about as fast as is safe for men to catch and turn in the rod ends for the following pass. Millmen, with tongs, handle the bars in the roughing or breakdown mill, and operators known as wire-catchers catch the ends and insert them in the next stand in the intermediate and finishing mills. These men become very skillful and go along for hours at a time without a miss or interruption. Many of these manual operations are replaced with mechanical apparatus in some rolling mills.

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Belgian Type Mills

THE mills just described are known as the Belgian type and are provided with sloping loop pits extending on both sides of the line of rolls to accommodate the loops formed as the wire rods re-enter the rolls. The pits have a slope of about 2¼ inches per foot. The roll diameters are adjusted to take the wire rod away from the preceding roll at about the same rate at which it is delivered. The roll diameter ratios have to be maintained fairly constant to give the speed necessary to accommodate the increased lengths and prevent the loops between passes from becoming too large. The percentage reductions, therefore, are not as large as could be made were each set of rolls independently driven and of the most favorable diameter.

IN some designs of mills the bars are automatically conveyed from the furnace to the first rolling pass. All operations are mechanically handled in the roughing mill, and on the sides of the intermediate and finishing mills which deliver a bar of square cross section there are employed circular repeaters, thus materially reducing the number of men required for these operations. Three rods are conveniently finished at the same time This requires accurate turning of the rolls and minimum wearing of bearings to get the same dimensions on all three rods simultaneously. The first pass commonly employed in the roughing mill flattens the wirebar to about one-half its thickness. This section is then stood on edge and returned through the rolls forming an approximately 2" square bar. From this second reduction, oval and square passes are alternated until the final round is made. This system permits the greatest reductions to be made and the fewest number of passes. From the finishing rolls the rods pass through mechanical winders of varous designs which wind them into coils about 36" in diameter. Copper ties are then put on the coils to keep them in shape for future handling. The coils are then stacked and allowed to cool before the pickling operation which is necessary before drawing.

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Requisites in Good Rolling

THE two main requisites in good rolling are uniformity of temperature at the start and plenty of cool water at a considerable pressure. The mill requires from 900 to 1000 gallons of water per minute, but a considerable portion of this water, when properly handled, can be re-circulated. Passes are designed to give definite reductions at a given temperature and any extreme variation in heat may result in imperfections. Some of the water is utilized on the roll bearings but the major portion is applied right on the roll grooves. An abundance of water is required to provide a chilling effect to keep the copper scale from adhering to the rolls, roughening up the surface of the stock and filling up the roll grooves. Were it readily feasible, hard steel scrapers riding in the grooves continually to keep them clean and smooth at all times might prolong the life of the groove. At one time the writer was required to roll a considerable poundage of ¼" rods with a longitudinal marker .020" to .020" the full length of the rod. After an hours operation the small slot in the roll required for the forming of this ridge was completely filled up with scale and it was found necessary to have a thin tool made from a hacksaw blade ride in this slot continuously to keep it clear.

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Accuracy in Rolling Dimensions

IN recent years more accuracy in rolling dimensions has been made possible due to mechanical improvements in adjusting the setting or distance that a pair of rolls is held apart. Some variation in acuracy is unavoidable commercially. For instance a $\frac{5}{16}$" rod from a 300 pound bar will be approximately 1000 feet long which means that the tail end of the rod will have at least ⅔ of a minute longer cooling time before finishing than the starting end. This time interval means a drop in temperature between the two ends of the rod and results in .010" greater diameter in the last end rolled than in the first end on a rod of this length.

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Reductions in Rolling

THE maximum reductions in the mill are obtained when all grooves are freshly turned and smooth. After a few hours operation they become slightly worn and pitted and the forward flow of the metal is retarded in favor of an increased side flow resulting in a less degree of reduction. For this reason several passes are rarely changed at the same time, but the time of changing is staggered so that a good surface is maintained and average reductions are obtained at all times. Grooves in the

intermediate and finishing mills with good hard chilled rolls will last from 32 to 64 hours. Finishing round holes will last from 40 to 50 hours depending on the roll hardness. They are changed when deemed advisable and not with any definite number of hours service in mind. The oval grooves wear faster than the squares and require changing at more frequent intervals.

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COPPER rods are normally 1/4, 5/16, 3/8, 7/16, 1/2, 5/8 and 3/4 inch sizes, depending on the use for which the rods are required. Special sizes and shapes may be rolled for any special requirements. The 5/16" rod is probably the most common size at the present time for general purposes and intermediate and fine wire sizes. The fact that a rod has a smooth and shiny surface at the finish denotes little as to its drawing quality; it may cover up fins, laps and cuttings rolled in somewhere during the operation which are of far greater importance from the standpoint of the quality of the finished wire. Good rods, besides care in rolling, require wire bars free from cold sets and inclusions, absence of porosity, of proper set and uniform dimensions and of the necessary purity. Five-sixteenths rods of good quality will readily draw down to size 50 B&S with no annealing and no trouble. Troubles experienced in wire drawing plants are often blamed on a faulty rod when many times it is traceable to the fault of the drawing operations themselves. Lubrication, die shape and improper annealing being wrong to any degree can eventually spoil the best rods.

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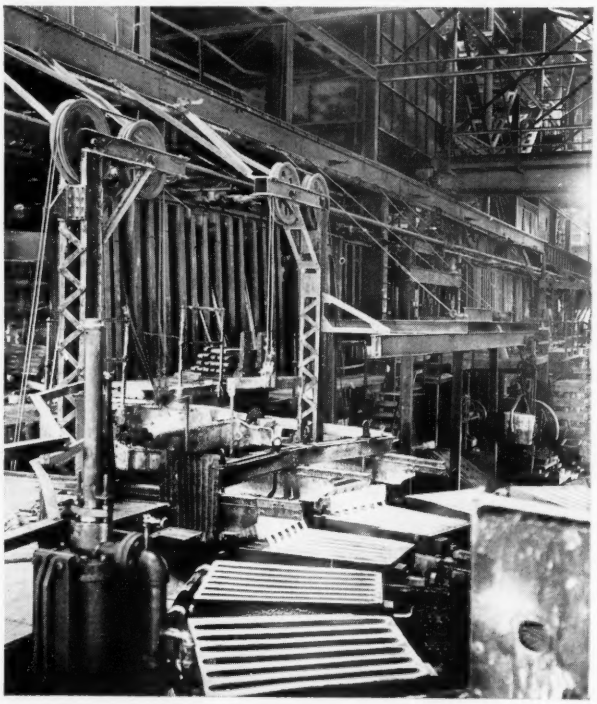
Specification For Hot Rolled Copper Rods

THE American Society for Testing Materials standard specification for hot-rolled copper rods for wire drawing A.S.T.M. B-49-26, is commonly used to specify the quality of the product. This specification also defines the quality and purity of wirebars to be used in producing wire rods. It allows variations in dimensions according to the size of rod concerned and states that the rod be free from all imperfections not consistent with the best commercial practice. Not so many years back it was more or less common to find fins in rods resulting from overfilling at some stage of the rolling or bad cuttings by guides, but due to mechanical improvements and a more exacting trade these things are rare today and totally unnecessary.



Casting wirebar, Anaconda Copper Mining Co., Great Falls, Mont. ✦

✦ ✦ ✦

Testing

ALL rod ends are trimmed back at the mill sufficiently to remove any undesirable end conditions. In many mills now it is common to crop the ends of the rod between the roughing and intermediate mills to insure complete uniformity. Twist tests of the rod being rolled are made periodically in the modern mill to determine the soundness of the ends, the samples being tested on a small hand machine. The usual test consists of first twisting the sample 8 or 10 times in one direction and then the same number of times in the reverse direction. Any defect in the rod will readily show up as a split or ragged lap. Both on the Continent and in America the trade is more particular about the ends of the rods as a result of the successful use of the electric butt-welder for joining rods for continuous drawing. Previously, in drawing down coil wire in certain size units, the ends were generally trimmed several times and any lap of this nature was automatically removed.

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Rod Sizes Regulated By Finished Products

VARIOUS sizes of rods are required to be rolled according to the finished product contemplated. The hardening of copper is proportional to the cold reduction of area made from the annealed state. Therefore rods are rolled of the necessary diameter to allow for the proper reduction to meet specifications for wire and cable. Rods may find their outlet in telephone line wire, bare transmission cable, weatherproof, enameled or silk covered wire, insulated cable, various sizes of square and magnet and special shapes for particular purposes, so that all rods have to be rolled of one quality adequate to meet the most exacting requirements.

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Scrap and Scale Reclamation

THE result of heating wirebar under oxidizing conditions, is that copper oxide scale forms on the surface, flakes off in the rolling operations and accumulates in the pits under the roll stands from

(*Please turn to page 349*)

Covering of Wire By Braiding

By S. B. Blaisdell

Engineer, Fidelity Machine Company, Philadelphia, Pa.

An outline of the development of braiding machines and methods, together with formulas for for the necessary calculations entering into the production of various types of braids and wire coverings.

THE art of insulating and protecting electrical conductors with braided fabrics has become so well known and is so commonplace that it seems as if we had always practiced the art. In reality it is of comparatively recent origin. According to a Census Report of 1919, the first braiding machine was imported into this country from Germany in 1824 and by 1860 there were seven concerns in Philadelphia making braids. In 1867 one concern was operating four hundred braiders, although there is no record to show how many of these machines were used for the covering of wires.

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Early American Developments

THE Report of Patent Commissioner lists the earliest American Braiding Machine Patent as taken out by John Thorpe of Pawtucket on August 10, 1821. Since this patent is not readily available it is worth while to diverge from the subject long enough to quote from it.

"This machine consists of wheels, the number of which is in proportion to the kind of braid or the number of strands that forms it. These wheels are placed in a circular form so that the carriers will have a direction pointing to the centre where the braid is formed. The inner surfaces of said wheels are concave, forming a curve corresponding with the circle on which they stand, and are of an equal thickness connected one with another, by cogs causing them to turn all together, and accurately on their centres, each forming its revolution in a proper time.

"There are two plates, whose surfaces form the same curve of the said wheels, one of which has a shaft confined to, and extending from its centre, passing loosely through the centre of the other steadying it.

"These plates, when together, constitute what I call a carrier, and is that part of the machine, which contains and carries a spool, bobbin or a strand, and are as many in number as the thread, or strand, required to form the braid, each of which is placed astride upon the rims of said wheels, and is pressed together by a spring, which causes them to pinch the wheels, producing a friction sufficient to hold them in their place, and is carried round in their proper route by the wheels as they turn shifting in their intercurrence from one wheel to another, which is effected by arms or studs. These arms or studs are confined, one to the carrier, and another steadfastly fixed to some permanent part of the frame, with its point extending so near to where the rims of the wheels come in contact as to interfere with the point of the one belonging to the carrier; and their position are such as to crowd the said carriers from the rim of one wheel onto the rim of another; and so on round from wheel to wheel alternately forming the braid. In the rims of said wheels are notches in which the shaft of the carriers lie, and by which they are steadied in their circulation. These notches are so arranged as to come exactly opposite each other, admitting the shaft of the carriers to pass between the wheels as they turn. There are other small notches in said wheels which receive a projection from the carriers, serving also to keep them in their places."

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IT will be seen that many features of this machine are embodied in the trackless type of Maypole Braider in use today for wire covering purposes.

✦ ✦ ✦

IN September, 1863, Mr. P. S. Devlan took out a patent for a Submarine Cable and describes it as follows:

"A coating of insulating and protecting composition is laid over the central wire, this is covered by a plaited cord, then again by a coating of composition, and so on until the cable is completed."

✦ ✦ ✦

THIS patent is the earliest one that the writer was able to find which mentioned a braided covering.

✦ ✦ ✦

THE records of the company with which the writer is connected show that the first machines they built for wire covering were sold to the American Electrical Works in 1870.

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Later Developments

IN October, 1893, the American Institute of Electrical Engineers standardized the number of strands and the diameter of strands to be used in making a wire or cable and designated the cross section in circular mils. Inasmuch as the braid is used primarily to protect the construction underneath it from mechanical chafe and injury, little attention seems to have been paid to the specifications of the braid for some time.

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IN 1909 the Navy required that all braid must be clearly woven and, silk braid excepted, must be thoroughly saturated with a black insulating waterproof compound, which compound will neither be injuriously affected nor have an injurious effect on the braid at a temperature of 95° C. (dry heat), or at any stage of the baking test, nor render the construction less flexible.

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IN 1915 Committee D-11 of the A. S. T. M., presented to the Society, Tentative Specifications for Insulated Wires and Cables, but

it was not until 1921 that braids were included in the specifications. These specifications have been revised this year and given the designation: D-34-T. They can be obtained from the American Society for Testing Materials.

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SINCE the making of braided coverings for wire has become so exacting and the majority of wires must be made to specifications which will pass the tests of the Underwriters' Laboratory, reference will be made frequently to these A. S. T. M. Specifications.

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Tables For Braiders

IN making out the tables, the following sizes of braiders have been selected 12, 16, 20, 24, 36 and 48 carriers. While the number of carriers and the number of ends per carrier used in applying the braid is optional. The braid must meet the limitation that it be closely woven from cotton thread having not less than two plies, and that the tangent of the angle between the cotton thread and the side of the wire shall not be less than the values given in Table IX, and the thickness shall not be less than the values given in Table X and Table XI with corresponding sizes and plies of cotton yarn; further the picks per inch shall not be less than the value as calculated by formula A.

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FOR convenience in calculating the more usual braid constructions, the formula for picks may be reduced to formula B.

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Machines For Standard Braids

UNDER these conditions it would seem wise to use the standard machines for standard braids as follows:

Dia. of wire under braid	
0.090 to 0.300	12 carrier
0.090 to 0.300	16 carrier
0.111 to 1.200	20 carrier
0.201 to 3.00	24 carrier
0.801 to 3.00	36 carrier
0.801 to 3.00	48 carrier

Formula A.

$$P = \sqrt{\left[\frac{1}{tE+M}\right]^2 - \left[\frac{C}{2\pi(D+T)}\right]^2}$$

where

P = the picks per inch;

T = the thickness of braid in inches; T = 2t

t = the thickness of one end of cotton, in inches; $t = \frac{0.0279\ K}{\sqrt{S}}$

K = cabling factor for plied yarn; values of K are: 2 ply = 1.60; 3 ply = 2.00; 4 ply = 2.36

S = the cotton ply, size or number;

E = the number of ends per carrier;

C = the number of carriers;

D = the diameter under braid, in inches;

M = the space between each set of carrier threads, in inches;

$$M = X\ (0.011 + 7.0\ t^2\ E^2)$$

X = the closeness constant

Values of X:	Diameter Under Braid, in.
1.1	0 to 0.500
1.0	0.501 and over

Formula B.

$$P = \sqrt{Y - \frac{Z}{(D+T)^2}} \quad \text{where } Y = \frac{1}{(tE+M)^2} \text{ and } Z = \left(\frac{C}{2\pi}\right)^2$$

FOR heavy braids a slightly different arrangement of machines is used:

0.90 to 0.200	12 carrier
0.90 to 0.300	16 carrier
0.126 to 0.500	20 carrier
0.151 to 1.000	24 carrier
0.501 to 3.00	36 carrier
0.801 to 3.00	48 carrier

✦ ✦ ✦

WHILE cotton braids have been mentioned exclusively in the above specifications, it will be of interest to note that jute and hemp are used in the manufacture of cables and asbestos in making of heat resisting insulations.

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Weights of Coverings Affect Cost

SINCE any data giving the weights of yarns or compounds used in making wire covering braids are of value in calculating the cost of these braids, the following formulas taken from Electric Cables, Their Construction and Cost, by Coyle & Howe, are included.

✦ ✦ ✦

THE weights in pounds per statute mile are as follows:

Cotton and Jute $1.53\ (D^2—d^2)$

Asbestos $2.34\ (D^2—d^2)$

Where D is the diameter over the braid and d the diameter under the braid, both expressed in millimeters.

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WITH hemp braids the weights vary with the size of the core. For instance, with a wire having a core diameter of 200 mils

the weight of the hemp braid would be 0.1415 (d 30.5) pounds per statute mile.

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SINCE the outside diameters of cables are important it is of value to note that

A braid of 8 oz. jute increases the dia. by 1.5 m m
A braid of 16 oz. jute increases the dia. by 2.0 m m
A braid of 2 lb. jute increases the dia. by 3.0 m m
A braid of 4 lb. jute increases the dia. by 4.0 m m

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THE sizes referred to above are the weights per nautical mile. The tensile strength of the material is roughly four times that of the weight of the yarn, a two pound yarn having an eight pound tensile strength.

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Hemp Braids

HEMP braids are preferred in some cases due to their higher tensile strengths. Italian hemp has a tensile strength of about ten to twelve pounds per pound of material per nautical mile. Table A gives valuable information regarding hemp braids.

TABLE A

Diameter of core in mils = d	Size of Hemp	Increase to diameter for 1 braid Mils	M.M.	Weight of Hemp in pounds per statute mile
40 to 200	4 oz.	40	1.0	0.091 (d 20)
200 to 1016	8 oz.	61	1.55	0.1415(d 30.5)
1016 & larger	16 oz.	87	2.21	0.185 (d 43.2)
Hecial Cables	32 oz.	140	3.56	0.296 (d 70)

Cotton Tubular Sleevings

ALL of the braids mentioned in Table A are applied directly to the cable or wire at some point in its construction. There is another class of braids used for wiring purposes which should be mentioned at this time, that is, the cotton tubular sleevings. These sleevings are used in two ways; as untreated fabrics which are placed over the ends of coils and afterward varnished or treated with the same finish as the coil, or as varnished or impregnated sleevings made in short lengths, having good electrical properties and useful in radio sets and switchboard work. These sleevings are made on machines having from 16 to 72 carriers and of various ends and counts of two ply yarns.

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The Braiding Operation

THE operation of braiding is very simple and for common wires, requires very little labor, for these reasons the bulk of the space has been used for the braids themselves.

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AT present the Maypole and Rotary types of braiders are used for braids requiring up to 24 carriers and the Maypole type of machine for the braids requiring 36 and 48 carriers. In either case the cost of producing the braid is small compared with the material cost and can be readily calculated.

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Production of Maypole Type Braider

THE production of the Maypole type of braider equipped with high speed carriers is at the rate of 64 carrier turns per minute, or 512 picks. The production of the Rotary braider is at the rate of 160 turns per minute, or 1280 picks; while for the new Textile machine it is approximately twice this.

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Power Requirements

THE power consumption and the number of machines per operator can be obtained from the catalogues of the manufacturers, the interest, depreciation, maintenance and repairs figured and a cost figure arrived at.

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SINCE both types of machines are used in different mills for producing the same braid and each mill claims his method to be the most efficient, it would be very interesting to have a discussion comparing such costs.

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Special Types of Braids

ALTHOUGH the braids mentioned in this article have been of the regular construction, it is possible to construct braids which will cover more than one conductor at a time, separating them from each other and enclosing them in one fabric. Other braids can be used for holding a number of conductors parallel, or for braiding them. In fact, due to the principles upon which it is constructed the braiding machine can cover wire with any desirable material such as paper or copper strip and do a good job of it.

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New Developments Pending

AT the present time considerable development work is being carried on by the Company with which the writer is associated in devising a fabric covering for wires and cables which can be applied in single or in multiple layers and which has many features enabling it to be produced more economically than the braided fabrics.

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THE WIRE ASSOCIATION
17 E. 42nd St., New York, N. Y.

Covering of Wire By Winding And Enameling

By Robert W. Withington

President, American Insulating Machinery Company, Philadelphia, Pa.

A discussion of the machinery, raw materials and processes relating to the winding and enameling of wire.

Historical

HISTORICAL data relating to the early days of the insulated wire industry may rightly, I believe, to be considered pertinent to the subject of this paper.

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ONE of the pioneers in the covered wire field was Alfred F. Moore, of Philadelphia, this Company established by Mr. Moore's father, Joseph Moore, was employed in 1820 in the manufacture of covered wire for framing the bonnets then largely in use by the ladies of that day, and tradition has it that Professor Morse, in his experiments in telegraphy, came to Philadelphia and had the wire for his coils covered by the Moore concern.

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BE that as it may, Alfred F. Moore, of Philadelphia, and Eugene Phillips of Providence, and the Ansonia Electrical Co. of Ansonia, were apparently the forerunners of the present day insulated wire industry.

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Early Insulating Machines

THE early machines consisted of a fixed spindle, hollow, on which rotated a flyer driven by a flat belt from a driving pulley below, the machines being horizontal, the tension was applied to the top of the cop by a flat steel spring and the wire covering was polished by two square wooden blocks held in suitable containers and kept in position by spring pressure.

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THIS particular machine was used for fine wire, while for heavier wires a single head machine, probably originating with Benedict & Burnham of Waterbury was used. This machine was similar in construction to the one previously described, but was of much heavier construction, having metal frames and cross members. The flyers and nose pieces were identical except for size.

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IN the meantime, the New England Manufacturers had departed from the horizontal type in favor of a multiple head, double sided, vertical machine driven from a central shaft to the individual spindles by means of a round belt, either cotton or leather, to a grooved pulley on the flyer shaft. To stop this spindle the operator threw off the belt by using a screw driver or similar tool, they became very proficient in this and the wire produced was equal to any demands made at that time.

All machines at present on the market are developments of those referred to above.

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Insulating With Cotton or Silk

PRIMARILY, the object of a cotton or silk covering machine is to apply an even layer of the insulating material to the wire. This is accomplished by means of a rotating flyer carrying the covering material in the form of a universally wound package; from this package the cotton or silk is applied to the wire through a nose piece mounted in the flyer spindle; this nose piece is hollow and the wire to be covered passes through the center; a polishing device is incorporated in the nosepiece to assist in giving a smooth even surface to the insulation.

EARLY in the development the method of putting up multiple ends of yarn on a pasteboard cop was devised, this vastly increased the production per spindle and the practice has been adopted in the application of the narrower widths of paper type up to possibly 3/8" wide, above which the paper is taken from the disk, mounted either eccentrically or concentrically as may be preferred.

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Cellophane As Insulation

THERE has recently been a serious attempt made to substitute for cotton or silk covering an application of cellophane or cellulose acetate tape. These materials can be obtained in widths as narrow as 3/64 inch and are put up in a Universally wound package similar to the ordinary cotton cop.

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OWING to the nature of the material, both the cellophane and the cellulose acetate, which has the trade name of Protectoid, require an adhesive to be applied to the wire before the application of the covering material.

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ONLY slight modifications of the standard equipment are necessary in order to run either material successfully.

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Types of Construction of Insulating Machines

A NUMBER of different types of construction as regards method of driving the spindles, etc., are in use and many costly refinements have been embodied in the design of wire covering machines.

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THE original machines as stated before were driven by belt to the flyer spindles, the capstan or pullout being driven by gear con-

nection from flyer spindle in ratio of five to one. This drive involved high velocity for the belt and the driving pulleys were then placed on the capstan worm shaft with a corresponding decrease in belt velocity.

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ONE drawback, and possibly a serious one, developed in the use of the belt drive; it was extremely difficult to keep ordinary flat belts at even tension and great differences in flyer speed were apparent with consequent loss in production.

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THIS condition led to the adoption of the all gear drive in which motion is imparted to the capstan worm shafts by means of bevel gears, the driving gears being mounted on a horizontal shaft immediately back of the capstan worm shafts and the motion being conveyed to the flyer spindles by spur gears in the regular way.

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THIS method gives uniform flyer speed throughout the machine providing that the cone clutches are kept in shape, the only drafback being the wear on the bevel gears. As now constructed, however one of the bevels is made of micarta or fabroid to reduce noise, and to replace gears all that is necessary is to unscrew the stud, take off the worn gear and replace with new one.

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THERE are a number of modifications of the gear driven machine in which hardened steel helical gears running in oil are used, these while materially more expensive have the advantage in maintenance cost and possibly run more smoothly. There have been instances in which machines so equipped running at 6000 R.P.M. have been running for over five years without any charge for maintenance.

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ANOTHER method of driving is by direct motor connection involving a motor for each spindle and an additional motor on the capstan all interconnected, making on a double cover machine a total of three motors to each line of wire.

THIS would seem to comprise the various machines used in the process of covering wire by the application of a spirally wound insulation. There are numerous variations in the accessories such as the flyers, tube carriers and nose pieces, but the opinion of the writer is that the simpler the machine that will attain the standard quality of product desired, the better will be the result as regards cost of finished material; this, of course, implies that in calculating cost that all items such as interest on investment and depreciation be considered.

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Enameled Wire

IN considering the question of enameled wire, it is probably not necessary to go back farther than the beginning of the present century. The art probably had its beginning in the Chicago district as at about that time the Western Electric Company was experimenting with a black coated wire; the principal incentive seeming to be the space factor involved, high dielectric attainable and comparative cheapness.

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SEVERAL Companies in that territory were shortly after engaged in the manufacture of similarly insulated wire and the process gradually spread to the East.

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Wire Enamels

WIRE enamel is basically a dipping, baking varnish of a very special type because of the conditions under which it must operate and the properties which the baked film must possess.

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IT is used to form a protective dielectric sheath around a metallic conductor which may be copper, aluminum, chrome alloy, steel or other metal. It is used because it forms a continuous uniform coating around the conductor and offers excellent "dielectric" and protective properties without the bulk of cotton or silk covering and at a considerably lower cost. Not only is the cost of enameled wire less than cotton or silk covered wire, but its use enables the manufacturer to wind more turns of wire into a given space, thus reducing the size of coils and housings.

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THE original wire enamel probably had an asphaltum base and was composed very largely of this material and linseed oil, together with other ingredients supposed to impart certain special features to the enamel.

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IN actual practice one very serious defect developed; enamel made to this formula would not withstand the action of transformer oil in which many coils were immersed in actual operation, so that while coils made from the original black enameled wire were entirely satisfactory when used dry, something better was required for general use.

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THE present day wire enamel generally consists of a combination of gums and oils with suitable solvents to hold the enamels in solution and aid them in flowing out into a continuous smooth film on the wire. Metallic driers may be incorporated to help the enamel to bake properly.

✦ ✦ ✦

Raw Materials For Wire Enamels

THE raw materials that can be used in wire enamels vary greatly in character and the raw materials used in any particular type of enamel are chosen for certain inherent properties that are desirable in the finished product.

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A GENERAL list of raw materials that might be used in wire enamels should include:

Gums: Rosin, Ester Gum, Congo Ester, Bakelite, Amberol, Backacite, Kauri, Congo, Manila, Gilsonite and Pitch.
Oils: Tung Oil, Linseed Oil, Perilla Oil and Fish Oil.
Driers: Lead, Manganese and Cobalt.
Thinners: Kerosene, Coal Tar Napthas, Saturated or Polymerised Hyrocarbons, Pine Oil and Turpentine.

✦ ✦ ✦

Characteristics of Proper Enamel

WIRE enamels should possess the following characteristics:

1. Be clean and free from any foreign substances which might impair the quality of the finished product.

2. Require a minimum of attention on the enameling machine.

3. Not jelly, liver or separate in the enameling machine under regular operating conditions.

4. Not gum up the sheaves or pulleys on the machine.

5. Build up a heavy film of enamel, free from defects, on the wire.

6. Be uniform in quality, gravity, body, solids content, color and working properties at all times.

7. Produce a baked enamel film of uniform thickness, color, free from lumps, holes, metallic particles or other foreign substances which might impair the quality of the finished wire.

8. Produce a film that is flexible, elastic and highly resistant to abrasion and possessing excellent adhesion to the wire.

9. Produce a film that resists the action of lubricating oils and varnish solvents.

10. Produce a film that is not tacky or sticky at room temperatures and not subject to softening under heat.

11. Produce a film having good dielectric properties.

12. Produce a film that does not deteriorate rapidly on ageing, i. e. retains the above properties over a long period of time.

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THERE are probably other points to satisfactory wire enamels, but the above will be found to cover the most essential characteristics.

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WIRE enamel is applied by combination dipping and baking machines. The wire to be coated is taken from the bare wire stands into a bath of enamel and thence through a baking chamber; this process is repeated as many times as there are coats of enamel to be applied, after which the wire passes to the Reeling Stand and the finished wire spools; the same process applies whether the ovens are vertical or horizontal.

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THE baking ovens are heated generally by electricity or gas, depending largely on the comparative cost of the heating element in the locality in which the plant is located. Electricity is generally conceded to be cleaner and more easily controlled.

✦ ✦ ✦

NUMBER of wires per unit will depend largely on the fancy of the customer, the maximum would seem to be 50, while the average is less than half that number.

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WHILE the general practice is to use vertical ovens, there are manufacturers who prefer the horizontal type.

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THE use of enameled wire formerly confined to the finer sizes is gradually extending to the heavier wires and flats.

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FOR much of the data on wire enamel, the writer is indebted to Mr. F. J. Emig, of the E. I. Du Pont de Nemours & Co.

✦ ✦ ✦

IN this brief paper treating of a very important subject, it has been possible only to give a resume of the salient points, and it is to be hoped that the discussion may bring out some interesting data.

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High Speed Carrier Developments

By R. V. Olsen,

Vice-President, Mossberg Pressed Steel Corp., Attleboro, Mass.

A paper submitted for discussion at the Braiding and Wire Covering Session of The Wire Association Outlining the advantages of high speed braider carriers in connection with the Maypole type of braiding machine.

THE Braiding Machine is one of the oldest, if not the oldest, machine for making textile fabrics and was in use before the Arkwright Power loom was invented.

✦ ✦ ✦

THE type of machine, as far as evidence goes, was the type that has become known as the May-Pole type Braider, and while the machine has been improved in detail, the mechanical principle is the same today as it was more than 100 years ago.

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ASSUMING that all interested parties are familiar with the general construction of the Carriers used on the May-Pole type braiding machines, this paper will not cover any of these general details.

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THE Carriers used in connection with this Braiding Machine have had great attention of many inventors and many patents have been granted. The aim of practically all, has been to increase the speed and to improve production. Singularly, however, the drop weight for tensionizing the yarn has been retained and it is this one factor which has been the cause of speed limitations.

✦ ✦ ✦

Development of High Speed Carrier

SOME years ago, it occurred to Frank Mossberg that the Braider Carrier could be materially improved by eliminating the take-up weight and substituting therefor a suitable spring, which in itself would be free from the action of gravity and other inherent disadvantages in the weighted type Carrier. Experiments were conducted along these lines of thought, which quickly proved the correctness of these theories and the results of these experiments were so promising that a patent was filed and manufacturing began in a small way. Since that time, numerous other patents have been granted covering improvements and modifications. Today, the High Speed Carrier is being used to advantage in practically all forms of braiding.

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IT was found that with this new Carrier, the speed of the Braiding Machine could be increased from 50 to 100% and in the majority of cases a more uniform product obtained.

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Causes of Increase In Carrier Speeds

THIS increase in speed was mainly due to the substitution of a compression spring, for tensionizing yarn in place of the tension weight. The speed of a Braiding Machine equipped with the old style weighted Carriers, was limited due to the action of centrifugal force acting on the drop weight which had a tendency of holding the drop weight against the standard, which caused undue friction of the drop weight sliding down the standard, thereby preventing a uniform tension on the yarn during the cycle when the Carrier passed from the outside of one quoit to the inside of the adjacent quoit. The higher the speed, the more obvious this became and this inherent disadvantage was eliminated in the high speed Carrier due to the substitution of the tension spring for the drop weight.

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IT was also discovered at that time, due to this uniform tension exerted by the tension spring, at all times, that greater tension could be applied to the yarn which resulted in the obtaining of a tighter braid with a consequent saving in the amount of yarn used.

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FROM the above facts it was reasoned that under most conditions, and which has later proven a fact, that above a certain speed the resultant tension on the yarn decreases when using weighted type Carriers. Whereas, with the use of a tension spring, take-up Carrier, the tension on the yarn increases with the speed.

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GREAT doubt was expressed in the beginning as to whether or not the Carrier and the Braiding Machine would last at this increased speed, but the results obtained in the trade during the past twelve years, has entirely eliminated this question and it has been proven that both the high speed Carrier and the Braiding Machine will last just as long at the increased speed as the Braider equipped with drop weight Carriers, operating at the slow speed. This has been made possible due to several reasons. The heartcam and the table opening of the high speed Carrier are all machined to the same predetermined dimensions. It is also made lighter in weight with a lower center of gravity, and all parts such as threadeyes, guide rods and other

parts are made of alloy steels, being hardened and tempered in order to obtain maximum service.

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Changes In Operations Due To Higher Speeds

IN order to obtain maximum benefits from the high speed Carrier, it was obvious that due to the higher speed, it became essential to reduce the doffing time, changing of yarn packages to a minimum and open-end pigtail threadeyes were incorporated in preference to the usual eyelet type eye, in order to accomplish same. For a like reason, it was necessary that the Carrier should accommodate the greatest amount of yarn possible. It is no doubt due to the adoption of the high speed Carrier by the braiding industry that so many braiding concerns have changed over to the use of universal wound, yarn packages in preference to parallel wound, double head Bobbins, as it was found that not only a greater amount of yarn could be had in a given space, but it was possible to increase the traverse of the package, as it was found in most cases that universal wound yarn packages were conducive towards easier yarn let-off action of the Carrier.

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High Speed Carriers Are Designed For Both Wood Or Steel Bobbins Or Cop Holders

THE high speed Carrier is so designed that it will accommodate either a wooden bobbin or a cop holder, as well as those made of steel, but in order to continue to obtain the highest rate of efficiency, best results have been obtained when using cop holders, or bobbins made of steel, due to the fact that the teeth do not wear the same as wood, therefore, a more positive and uniform yarn let-off action is obtained from the Carrier.

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THE high speed Carrier is now being made in such a manner that the tension spring can be removed very rapidly, a feature which is most appreciated by braid manufacturers whose work requires the changing of tensions constantly, and is so designed that it will accommodate springs equivalent to practically any tension required and so constructed that most any product can be handled with equal facility.

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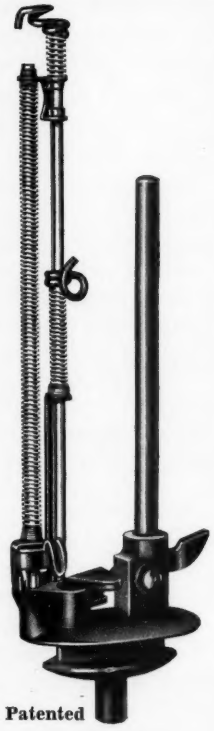
IT has often been stated by various braid manufacturers that the high speed Carrier, referred to herein, has been the most outstanding improvement in the May-Pole type of Braiding Machine since its inception.



Patented

2BX Mosspeed Carrier

Mosspeed Braider Carriers

REPRESENT

Improved Braiding At Lower Costs

The patented Mosspeed spring tension take-up makes it possible to increase the speed of the maypole-type braiding machine. An effective increase of 80% is being obtained in many cases.

The new (X) type Mosspeed Carrier permits the rapid changing of tension springs making this an ideal carrier for braiding all kinds of yarn (cotton, rayon, asbestos, jute), in addition to fine strands of copper wire.

Consult Our Engineers Regarding Your Braiding Problems.

MOSSBERG Pressed Steel Corp.

Attleboro, Massachusetts, U. S. A.

Greenville, S. C. Dallas, Texas

Selson Machine Tool Co., Ltd., London, England

Patented

Open Center Vulcanizing Drum

OTHER PRODUCTS

STEEL SPOOLS
STEEL REELS
VULCANIZING PANS
IMPREGNATING REELS
DETACHABLE HEAD SPOOLS & REELS
ANNEALING AND STRANDING REELS
COPHOLDERS
AND
BRAIDER BOBBINS

Lubrication For Drawing Copper Wire

By John G. Richards

Lubricating Engineer, G. Whitfield Richards, Philadelphia, Pa.

A discussion on lubrication for drawing copper wire in the three ranges; heavy, medium and fine sizes.

IN considering the adaptability of any lubricant to the drawing of copper rod in continuous machines, it is necessary to first determine if certain fundamental physical characteristics are present, and moreover to find out if these essential qualifications are compounded in correctly balanced proportions. This information may be obtained through simple laboratory tests which are familiar to the average chemist, and by means of such chemists equipment as is usually present in the average plant laboratory.

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IN fact, much may be saved of the expense of conducting costly machine tests if such determinations are first made in the laboratory, for it is certain that a lubricant which is lacking in these essential characteristics will not perform satisfactorily in the machines.

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Selection of Base For Lubricants

SINCE considerable heat is generated in even the slowest of continuous rod machines, water is necessary as a cooling medium, and therefore water emulsions of fats with sufficient "lubricity" are most efficient for the purpose. Since soap is undoubtedly the best and cheapest emulsifying agent, and also because soap possesses some lubricating value, it is to be preferred as a carrier or "base" for the emulsion. Care must be exercised in selecting the proper soap for this purpose, however, as low titre soaps break down; harsh soaps stain the wire; and sticky soaps gum the carriers and capstans. Other soaps foam excessively, or congeal when the machines are idle, and build up a messy film.

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Determination of Type of Fats To Be Used

PERHAPS no other type of cold drawing work places such a heavy burden upon the drawing lubricant as does the cold reduction of heavy wire through multiple dies. Therefore, only fats of the highest order may be used. In selecting these fats it should be remembered that the physical properties of the same must be determined as of a temperature approximating 210 degrees F., which temperature, or a somewhat higher one, prevails at the bearing surface of the dies when the machine is in operation.

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MANY different physical properties have a direct bearing on the efficiency of the fat,—such as viscosity, flash point, titre, cohesion, and film strength,—but for general guidance, tests for viscosity and for flash point will suffice.

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FATS of a lower order than tallow, with a viscosity of approximately 50 Seconds (Saybolt) at 210 degrees F. and a flash point of 650 degrees F., cannot be used successfully. By proper blending and processing on the part of the manufacturer who is adequately equipped, the viscosity of the fat may be built up to approximately 300 Seconds (Saybolt) at 210 degrees F., and the flash point considerably raised, with the result that the efficiency of the compounded fat is far better than that of tallow.

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WHEN such a fat is blended with a suitable soap in correctly balanced proportions, very dilute mixtures of this drawing compound, with water, may be used.

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Effect of Improper Solutions

ONE per cent solutions will give long, trouble-free runs, with satisfactory die life. It should not often be necessary to dip the rod into a preliminary bath of lubrication before it enters the machine, especially if a wad of the lubricant (undiluted) is placed in a box ahead of the first die.

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IF, however, incorrect proportions are used by the manufacturer of the lubricant, it will be found necessary to add fat or soap, as the case may be, in order to keep the machine running at all. Incorrect proportions of soap or fat are responsible for slippage on the capstans, and excessive wear thereof; for offsize finished wire; and frequent breakage in the weld or otherwise.

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IF fat of a low order is used, it will be found necessary to use much heavier solutions. Such heavy solutions have a tendency to excessive flotation of copper dust in the lubricant, which collects in the mouths of the dies. This condition is responsible for abnormal wear in the lead angles, which is

sometimes referred to as "ringing out" or "necking out".

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STAINED wire can almost always be traced to impurities in the lubricant, such as traces of sulphur or salt that have not been removed from the fat, or spent lye that has not been settled out.

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Wires From Alloys of Tin And Copper Must Be Cleaned

WIRE from alloys of copper and tin does not come clean from the pickling baths. Tin oxide in the form of a whitish powder remains on the surface, and no lubricant can overcome its abrasive nature. It is therefore necessary to tumble such wire, after pickling, or, if tumbling equipment is not available, to dip the wire into a special alkaline cleaning solution, and to rinse again before cold drawing.

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Lubricants For Medium And Fine Copper Wires

GENERALLY speaking, a lubricant that will perform satisfactorily in the rod machines on heavy copper wire will work just as efficiently on intermediate sizes and on fine wire if more dilute solutions are used. However, intermediate and fine sizes **can** be drawn in lubrication where less free fat is present, and therefore compounds of a high soap content will work on the smaller sizes and yet fail to perform on heavy wire. It should at all times be borne in mind that maximum die life can only be obtained from drawing solutions that contain the greatest possible amount of free fat, regardless of the size of the wire being drawn.

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Uniform Consistency Means Increased Efficiency

INCREASED efficiency can be obtained from the drawing lubricant by maintaining a uniform consistency or richness thereof. Daily checks of its consistency can be made in a very few minutes by means of a quite simple test, as follows: Place fifty C.C.'s of the lubricant into a graduated test tube and add to the same three C.C.'s of sulphuric acid; shake carefully and allow to stand until the fat floats to the top of the solution. Allowing for the three C.C.'s of acid present, compute the per cent of fat contained in the lubricant, and make additions to the machine or system accordingly. Daily additions of small amounts, rather than less frequent additions of larger amounts, make for better uniformity.

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Former Problems of Machine Operators

BACK in the days of the "homemade" lubricants, and when chilled dies only were available, the operator of a continuous rod machine was obliged to be a veritable wizard in his profession. His bag of tricks contained many secret formulae for drawing lubricants, and some of the ingredients thereof were of a truly surprising nature. Especially when considered from the standpoint of sanitation and healthfulness.

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BUT he never even dreamed of getting the rate of production from his machine that is every day practice in the modern wire mill. Even the best of his secret lubricants would have failed to stand up to the job of taking down 5/16" copper rod at the rate of 2600 feet per minute; and he was not called upon to produce phosphor bronze, silicon bronze, and other difficult alloys.

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IF his finished wire stained, he blamed the weather, or fumes from the pickle room; if his day's

(*Please turn to page 355*)

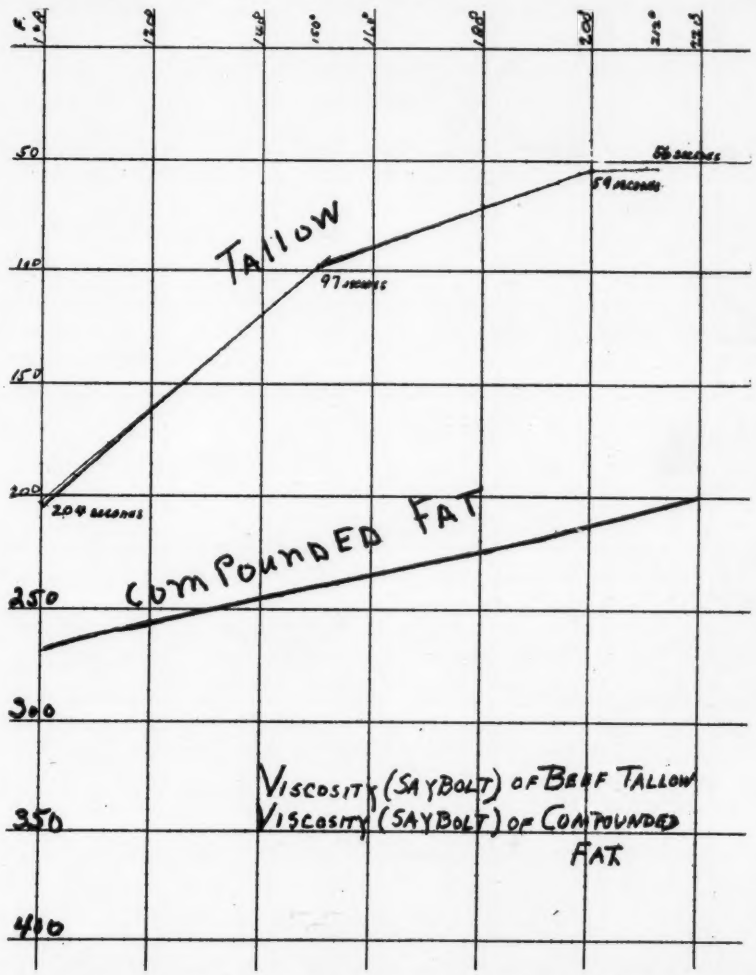

Chart showing the relative decline in viscosity in the presence of heat, of tallow as compared to a properly compounded fat.

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All Wire Mill Men Are Invited to Attend The Wire Association 1934 Meeting and Exhibition

At New York, N. Y., October 1-2-3-4-5, 1934

Held in Association With the National Metal Congress

PROGRAM COMMITTEE

F. A. Westphal, Supt. Wire Mills, Sheffield Steel Corp., Kansas City, Mo., Chairman

H. W. Anderson, Pres., Fidelity Machine Co., Philadelphia, Pa.
S. A. Braley, Industrial Fellow, Mellon Inst. of Industrial Research, Pittsburgh, Pa.
Allan B. Dove, Chemical Eng., Steel Co. of Canada, Ltd., Hamilton, Canada.
Paul R. Fast, Superintendent, Belden Mfg. Co., Chicago, Ill.
P. W. Grassell, Pres., Wilson Steel & Wire Co., Chicago, Ill.
D. Horsfall, Works Mgr., Canada Wire & Cable Co., Ltd., Toronto, Ont., Canada.
M. A. Kent, Asst. Gen. Wks. Mgr., General Cable Corp., White Plains, N. Y.
U. C. Tainton, Metallurgical Engineer, Baltimore, Md.

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AT the technical sessions to be held Tuesday, Wednesday and Thursday, the papers will be brief and will be limited to two per session. It is intended that the time shall be spent in open discussion and exchange of experience in matters of general interest to wire mill operating men.

\+ + +

THE discussions will cover, so far as time permits and in addition to matters arising naturally out of the papers read, a number of topics which have been suggested by members. These discussions are open to all.

\+ + +

IN addition to the program set forth, a splendid opportunity is offered to discuss informally, routine problems and to exchange opinions and ideas regarding equipment and processes used in the industry. For this purpose informal gatherings are held at Wire Association Headquarters in the Hotel New Yorker which are open from 9 A. M. to 12 P. M. (Midnight) during the convention.

THERE WILL BE A REGISTRATION FEE OF $5.00 FOR THOSE ATTENDING THESE TECHNICAL SESSIONS AND INFORMAL MEETINGS.

ADMISSION WILL BE BY BADGE ONLY

Every wire mill production executive engaged in the manufacture or fabrication of wire and wire products of any kind is invited to attend.

REDUCED RATE RETURN TRIP RAILROAD CERTIFICATES FURNISHED TO MEMBERS OF THE ASSOCIATION

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Make Your Plans Now to Come and Participate in the Discussions

For detailed information address RICHARD E. BROWN, Secretary

THE WIRE ASSOCIATION

17 East 42nd St. New York, N. Y.

❖ PROGRAM ❖

Monday, October 1, 1934, at Hotel New Yorker

A. M. and P. M.—Registration—"Get Together"
P. M.—Informal meeting at headquarters of The Wire Association

These informal meetings will be held every night from 8 to 11 o'clock during the convention.

The Technical Sessions

TUESDAY, WEDNESDAY AND THURSDAY, OCTOBER 2-3-4, 1934

To Those Attending the Meeting
stenographic copies of the discussion will be available
at $2.50 per copy.
To all others $5.00 per copy.

Tuesday, October 2, 1934

MORNING SESSION AT HOTEL NEW YORKER, 9:30 A. M.

Subjects—Galvanizing and Corrosion Resisting Coatings.

Frederick A. Westphal, Superintendent Wire Mills,
Sheffield Steel Co., Kansas City, Mo.
Chairman of Meeting.

Paper A.—"Corrosion and Hot Galvanizing".

The theoretical and practical galvanizing of wire with consideration of the mechanism of corrosion.

By Allan B. Dove, Chemical Engineer,
Canada Works, Steel Company of Canada, Ltd., Hamilton, Ont., Canada.

1. What type of flux has been found to be the most satisfactory?
2. What are the advantages of washing off the Iron Chloride and substituting a tri base flux?
3. What effect does length of time of immersion in the molten Zinc have on the thickness of the coat?
4. What is the best material for wipers for round and flat wires?
5. Is there any suitable covering for galvanizing pans on fine wire which will reduce appreciably the ash production?
6. Is there any material which may be used as a covering for tinning pans during use, in order to prevent excessive ash production?
7. Welding of Wires for galvanizing.

At Rylands Australia Ltd. we have for some time, been welding rod and wire on our continuous drawing machines, which draw wire for netting.

On trying to weld wires on the galvanizing plants, many difficulties were encountered.

It was found impossible to weld any wire which was sold on its tensile strength because the wire was of low tensile at the weld due to annealing after welding.

When welding was tried on soft wires, it was found that the welds would stand all the physical tests (tensile, elongation, twists, wrapping 8 on 8 off, bend) except the bend test and elongation was poor, that is to say with any certainty. It was found that welds could be made to stand as many bends and give just as good elongation as the wire itself provided the weld was not bent or twisted after welding, to see if the weld was good or not. If the weld cannot be tested after welding it makes the job rather hazardous.

We use an A. C. resistance welder, with an attachment for annealing the weld after it is made.

A. Is welding carried out very much in American mills for galvanizing?

B. What kind of welder is most used?

C. Do mills have any trouble with welds breaking or failing in physical tests?

D. How many welds does an average operator make in an hour?

AFTERNOON SESSION—HOTEL NEW YORKER, 2 P. M.

Subjects—(a) Electrolytic Copper. (b) Lubrication—(c) Dies.

Paul R. Fast, Superintendent,
Belden Manufacturing Co., Chicago, Ill.

Chairman of meeting.

Paper C.—"Smelting, Casting and Rolling of Electrolytic Copper".

By W. S. Adams, Superintendent of Rolling Mills, Anaconda Wire & Cable Co., and R. H. Miller, Superintendent of Refineries, Anaconda Copper Mining Co., Great Falls, Montana.

Paper D.—"Lubrication For Drawing Copper Wire in the Three Stages—Heavy, Medium and Fine Wire".

By John G. Richards, Wire Mill Lubricating Engineer,
G. Whitfield Richards, Philadelphia, Pa.

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8. How do highly polished, hardened steel rolls compare with cast iron rolls in regards to wearing qualities?
9. What has been the experience with Oxygen Free copper, welding of rods, drawing properties, smoothness of wire drawn, comparative ductility, and is a higher annealing temperature needed?

LUBRICATION

10. What types of dips are used in the three steps, Heavy, Medium and Fine drawing?
11. What tests are made on the various dips to keep the uniform consistency as regards to lubrication and chemical characteristics? Is the compounding of the dip mixture left to the operators on the machines?
12. What have been found to be the most desirable properties for soaps for drawing steel and brass? What moisture content may be permitted?
13. What lubricant is generally used and recommended to to get the best results for drawing cold heading wire?
14. What lubricant has been found to give the most results for producing extra bright wire at high speeds?
15. What lubricant has been found to give the best results for drawing the ordinary grades of low carbon wire through Tungsten Carbide Dies?

DIES

16. What has been the experience during the past year toward greater die life in connection with the use of Tungsten Carbide Dies?
17. What substitute is being considered or experimented with at the present time to replace tantalum and Tungsten Carbide for making wire drawing dies?
18. What has experience taught as being the proper length of bearing and approach angles on dies for drawing both low and high carbon wire?
19. How are small diamond dies inspected as regards to shape?
20. What shapes are used in dies from .01 to .003 are the same angles used on all dies in this range?

Wednesday, October 3, 1934

MORNING SESSION—AT HOTEL NEW YORKER, 9:30 A. M.

Subjects—(a) Annealing and Heat Treating—(b) Steel Wire Manufacture

P. W. Grassell, President,
Wilson Steel & Wire Co., Chicago, Ill.

Chairman of meeting.

Paper E.—"Bright Annealing of Wire in Electric Furnaces".

Recent developments in annealing both ferrous and non-ferrous wire and strip, and a discussion of the latest types of furnaces involving the uses of controlled atmosphere.

By O. S. Haskell, Industrial Heating Engineering Dept.,
General Electric Co., Schenectady, N. Y.

21. What is the experience of the Wire Mills in the use of partially burned illuminating gas, or the equivalent, as an inert gas in the annealing of copper wire?
22. How does gas compare with electricity as a medium for heating annealing furnaces for copper wire as regards
    1—Uniformity of anneal
    2—Brightness
    3—Cost
    4—Softness

Topic F.—"Steel Wire Manufacture". (A Lecture)

By F. H. Nullmeyer, Superintendent Rod, Wire & Conduit Dept.,
Youngstown Sheet & Tube Co., Youngstown, O.

Illustrated by motion picture showing manufacturing processes of Youngstown Sheet & Tube Co.

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23. What has been found to be the best coating for steel rods, for high production and long die life? Would a thin skin coat be considered most efficient?
24. How may an even sull coat be produced on rods for welding wire? Difficulty is often met in producing a coat which will stand slippage on the block and still remain unbroken. What acidity has been found most suitable in coating spray?
25. How do the changes wrought in the structure of steel during continuous drawing, compare with those during single hole drawing?
26. How may a simple control be kept on copper coating solutions to insure uniformity of coating and tightness?

AFTERNOON SESSION—HOTEL NEW YORKER, 2 P. M.

Subject— Braiding and Wire Covering Wire

Joint Session With the Braiding and Wire Covering Machinery Manufacturers Association.
(Admission to session by card. No registration fee required for this meeting.)

H. W. Anderson, President,
Fidelity Machine Co., Philadelphia, Pa.
Chairman of meeting.

Paper 1—"Covering of Wire by Braiding".

By S. B. Blaisdell,
Fidelity Machine Co., Philadelphia, Pa.

Paper 2—"Covering of Wire by Winding and Enameling".

By Robert W. Withington, President,
American Insulating Machinery Co., Philadelphia, Pa.

Paper 3—"High Speed Carrier Developments".

By R. V. Olsen, Vice-President,
Mossberg Pressed Steel Corp., Attleboro, Mass.

27. Are automatic stops an aid or detriment, as regards production when applied to serving machines, more particularly in connection with the application of cotton or silk in solution?
28. What would be considered the maximum flyer speed for cotton or silk serving machines?
29. How many lines of wire .010 diameter would be regarded as being a task for an operator?
30. Which is to be preferred, electricity or gas as a heating element for Enameling Ovens?
31. What is the relative cost of braiding with Maypole type Braiders equipped with High Speed Carriers as compared to the old style weighted Carriers and also comparison to the so-called High Speed Braiders?
32. What is the comparison between High Speed Carriers and old style Weighted Carriers in regard to the amount of yarn used in certain types of wire.
33. What is the comparison of quality of braid produced?

ANNUAL MEETING OF THE WIRE ASSOCIATION

Presiding
John Mordica, Superintendent, Rod & Wire Mill,
Bethlehem Steel Co., Sparrows Point, Md.
President of The Wire Association.

✦ ✦ ✦ **Award of The Wire Association Medal** ✦ ✦ ✦

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Thursday, October 4, 1934

MORNING SESSION—HOTEL NEW YORKER, 9:30 A. M.

Subjects—(a) Spring Wire—(b) Lime Coating.

Dr. S. A. Braley, Industrial Fellow,
Mellon Institute of Industrial Research, University of Pittsburgh.
Chairman of meeting.

Paper G.—"The Properties and Manufacture of Spring Wire".

Discussing the relative physical properties of spring wire dependent not only upon chemical composition but also on the details of manufacturing procedure.

By E. J. P. Fisher, Physical Metallurgist,
Keystone Steel & Wire Co., Peoria, Ill.

34. Scaling of Wire Rod on Continuous Rod Mills.

Here in Newcastle we have a 16 stand Morgan continuous rod mill which rolls two stands at once, producing about 140 tons of 5 rod per 8 hour shift. Rolling temperature on low carbon rod is about 1130°C., the rod leaving the finishing stand at approximately 980°C. In order to reduce the scale on the rod and in turn reduce our cleaning acid costs, we cool the rod as it leaves the finishing stand of the mill by passing each strand through a scaler.

In order to cool the rod sufficiently to form a scale of about 0.5% of the total weight of the rod, we pass about 10,000 gallons of water at 55°F., per hour through the scalers, if the temperature of the water rises to 65°F. as it does in the Summer, about 12,000 gallons per hour is required through the scalers to give the same effect. (This is 5000 and 6000 gals. per hour per scaler respectively.)

By doing this we find that we save 2% of steel and reduce our acid cost considerably.

1. What is American practice with regard to scaling?
2. Please give sketch of scaler most used, with water flow, and average percentage scale on scaled rod.
3. What is general acid consumption in pounds of H_2SO_4 (100%) per ton of rod cleaned in mills using scaled rod.

35. Cleaning House Processes.

In our cleaning house we clean scaled rod, unscaled rod, pat-

ented rod, patented wire, and annealed wire, the wire cleaned amounting to about 8% of total, but acid figure is worked out only on total rod tonnage cleaned and is about 40 lbs. H_2SO_4 per ton of product cleaned. We at the present time can only scale low carbon 5 rod, the rod mill coilers will not work with heavier sizes if they are scaled.

Do American cleaning houses have any method of removing fume from the cleaning vats or do they find that a restrainer is sufficient to prevent fume?

We use a gelatine glue as a restrainer but this is rather inefficient and the fumes in our cleaning house are at times very bad. Restrainers such as Rodine and No Pit, etc., have been tried by us but were ruled out on account of their expense in Australia.

Paper H.—"Lime Coating of Rod vs?".

The use of Silicate of Soda and/or Trisodium Phosphate in place of lime in drawing rod and wire.

By H. G. Hobbs, Cleveland, Ohio.

Any complete investigation into the use of silicate of soda or tri sodium phosphate as a substitute for lime in rod and wire drawing is certain to raise, along with many others, the following questions:

36. What is the life of a silicate of soda or tri sodium phosphate coating solution in comparison with a lime solution?
37. Can the pickling operation be controlled and supervised to the point where baking is not necessary for the relief of hydrogen embrittlement regardless of the analysis of the rod?
38. If baking were eliminated, how long a period of storage at room temperature would be necessary to relieve any embrittlement which might impregnate the rods regardless of pickling control?
39. What is the danger of caustic embrittlement with the use of these two products, and can a practice be set up which will prevent it with ordinary care?
40. What is the approximate length of immersion necessary to heat rods up to the temperature of the coating solution, regardless of their size?
41. Is there a simple, economical relief for caustic embrittlement?
42. What is the best substitute for lime; silicate of soda, tri sodium phosphate, or a combination of the two; if the latter, what proportions of each?
43. Can a coating of silicate of soda or tri sodium phosphate be used sufficiently?
44. What strength of alkalinity is most suitable for general rod coating; and what is the highest alkalinity possible before the self-drying feature is lost?
45. How long can rods coated with silicate of soda or tri sodium phosphate remain on the floor without rusting—how does this compare with lime?
46. Will silicate of soda or tri sodium phosphate work as well as lime with all four classes of lubricants: soap, oil, grease and stearate?
47. Are the effects of high or low wire block speed, light or heavy drafts, composition and design of die, and type of lubricant used, the same and in the same direction with silicate of soda or tri sodium phosphate, as they are with lime?
48. Is wire drawn from rods coated with silicate of soda or tri sodium phosphate completely free from coating streaks?
49. Is finished wire drawn from rods coated with silicate of soda or tri sodium phosphate less susceptible to rust than that drawn from rods coated with lime?
50. Does the analysis of the rod being coated affect the efficiency of silicate of soda or tri sodium phosphate, or is each universal in its application, as is lime?
51. In view of the comparable cost of silicate of soda and of lime, are the advantages and economy of the former such as to warrant its use even though baking is not eliminated?
52. In view of efforts toward increased production, are the advantages of silicate of soda and tri sodium phosphate sufficient to warrant breaking open all coils of small gauge wire and reducing the number of coils on a pin to the point where self-drying would be induced?

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AFTERNOON SESSION—HOTEL NEW YORKER, 2 P. M.

Subject—Copper From Mine to Wire.

M. A. Kent, Assistant General Works Manager,
General Cable Corp., White Plains, N. Y.
Chairman of meeting.

Paper I.—"Canadian Copper From Mine to the Wire User".

Dealing particularly with the historical, economical and manufacturing phases of the industry.

By D. Horsfall, Works Manager,
Canada Wire & Cable Co., Toronto, Canada.

53. In tinning copper wire which process gives the best results—
    a—a flux bath ahead of the tinning tank
    b—merely a mop of flux saturated waste across which the wires pass?
54. What is the maximum speed of wire feasible in the tinning bath for heavy, medium and fine gauge wires?
55. Gauges in each case together with most desirable or economical speeds.
56. What quantity of tin is it desirable to have in the bath, as the size of the wires increase, in order to supply the copper loss of heat?
57. Is a constant wire speed necessary or even advantageous or may the speed of the wire increase as the reel (which revolves at constant speed) fills with wire?
58. Is tension on the wire desirable or undesirable other than that such tension requires more horsepower? Of course, tensions which will not stretch wires are referred to.
59. At more than what number of separate lines of wire to a bath does operation become cumbersome or otherwise objectionable?
60. Is extra expense of independent pick-up clutches warranted to control each line of wire or may all lines of wire be stopped in the bath without deleterious effect, when it is necessary to change reel on one line of wire?
61. Several methods of heating the tin tank are possible by coke, oil, gas or submerged electric heaters with the advantages, first cost and operating cost, maintenance, etc. of each method. Is thermostatic control used?
62. A most important item is the cost of tin or weight of tin in pounds per 100 pounds of copper. What percent should this run in (a) heavy (b) medium and (c) fine wire? What substitutes can be used for the prevention of dross forming (asbestos, finely divided carbon, etc., to cover the tin bath). Figures in costs and savings.

FLUXES *for*

Hot Galvanizing — Tinning — Lead Coating

for

WIRE and WIRE PRODUCTS

Correctly made for easy use to produce superior results economically.

Consult us about proper Fluxes and Fluxing to secure complete, smooth, ductile and adherent coatings.

H-VW-M Fluxes are giving complete satisfaction to prominent Wire and Wire Products Manufacturers.

HANSON-VAN WINKLE-MUNNING

HANSON-VAN WINKLE-MUNNING COMPANY, MATAWAN, N.J.

978

ANNEALING REELS SPOOLS PROCESS REELS

The American Pulley Company

Philadelphia

Spools For Steel Reels

Spools to the Trade For All Purposes

Let Us Help You With Your Reel and Spool Problems

✦ ✦ ✦

WALTER A. RICHARDS

Specialist on Reels and Spools to the Copper and Steel Wire Industry Will Maintain Headquarters at the Hotel New Yorker During the Wire Association Convention, Oct. 1-5, 1934

STRANDING REELS BRAIDER REELS VULCANIZING REELS

Registry of Used Wire Machinery

We Offer–Subject to Prior Sale–The Following Used Wire Mill Machinery

No. 237
Electric Resistance Pointers, Capacity .148

No. 282
Waterbury No. 1 Straight Roll Machines, With Spooling Attachment.

No. 302
9 Die Richards Continuous Machine For Copper Rod

Waterbury stand spooler for fine wire.

No. 321
Electric Platform Truck Capacity 6000 lbs. Platform 41″ x 82″ x 22½″ High
24 Cells Edison A-6 Batteries

No. 342
Nilson Power Press B 2

No. 348
Five-block rod bench with gear drive and motor, 26″ and 22″ blocks.

No. 400
Twenty head enameling machine complete, capacity down to .001.

No. 401
Eight head spooler, capacity 200 lb. spools, motor driven.

No. 402
Hayes electric furnaces, automatic control, with 32 head spooler, for fine wire.

No. 403
Waterbury straight roll fine wire machines, motor and belt drive.

No. 406
Die Reaming Lathe, Semi-automatic.

No. 408
Barron and Crowther 3 hole continuous wire machines, ranges from No. 5 rod to 21 gauge.

No. 409
Wire pointers for bench or post mounting, ¼ to No. 12.

No. 418
Five 4-penny nail machines (German design)

No. 432
24 block intermediate frame with 16″ blocks, reducer, and pulley drive.

No. 438
12 block fifteen frame with 16″ block, with gear drive.

No. 439
The following mail machines—1 Roofing nail—9 eight and ten penny National—4 eight and ten penny Macke—1 eight penny Macke—4 eight and ten penny Macke—2 six penny Macke—5 six penny National—7 form penny National—6 form penny Macke—3 three penny Macke.

No. 440
3 bale tie machine with 3 H. P. motors.

No. 441
Vaughn scrap baler.

No. 442
Sears scrap baler.

No. 443
2 Adt. & Son #11 rod straighteners.

No. 444
1 Shuster #18 rod straightener.

WE HAVE BUYERS FOR THE FOLLOWING

No. 360
Wanted
No. 1 Tor and No. 1 Universal and No. 3 Universal Sleeper & Hartley Coilers.

No. 382
Rivet Machines No. 0 or No. 1 Waterbury or Manville.

No. 384
Florist Wire Machines.

No. 411
A 5-keg nail tumbler.

No. 412
Tensile testing machine for low carbon wires No. 5 to No. 25 gauge.

No. 413
U. S. S. M. Power Eyeletting machines, type B.

No. 414
Two take-ups. 60″ reel by 32″ traverse, with jacks, and chain drive from capstan shaft, also two let-off stands, and 36 x 8 capstans with spur drive.

No. 415
Paper wrapping machine, coils 16″ to 22″, 100 lb. weight, Terkelsen 1C or equivalent.

No. 416
Small riveting machines, Townsend No. 1 or equivalent.

No. 419
Single spooler, 6½ x 6½ for No. 20 hard basic.

No. 420
4 block rod bench, 22″ or 24″.

No. 423
Automatic roll feed for press, 2″ stroke, stock 3″ x 1/16″.

No. 425
Lewis-Shepard lift trucks, about 45 x 20, height 6″.

No. 426
Loom for brass, copper and bronze, 100 mesh.

No. 427
2¼″ x 6″ c. r. mills with take-ups.

No. 429
Rod and wire trucks.

No. 430
Double stroke cold headers, Waterbury or Manville No. 0, up to 3/16 wire 1″ blank.

No. 433
Electric butt welder, 8 to 16 ga.

No. 434
Electric spot welder for wire and light sheets.

No. 435
Nail machine (roofing) ⅝″ head on 12 ga.

No. 436
Flattening mill for .10 x .014 stapling.

No. 437
Tensile testing machine for .090 music wire.

Dunscomb Associates

BOX 320, C/O WIRE AND WIRE PRODUCTS — 17 EAST 42nd ST., NEW YORK, N. Y.

REGISTRY OF USED WIRE MILL MACHINERY

Cooling Wire Dies

By Leon Simons

IN recent years some very significant changes have taken place in the dry drawing of high and low carbon wire. The advent of tungsten carbide was largely responsible for a marked reduction in the die cost in the production of this type of wire.

✦ ✦ ✦

MILLMEN, still looking for further advances, have resorted to various types of holders to improve the quality of their wire and to effect a longer life in the die. Experience has taught them that a cooler die will show a marked increase in life. A better finished wire due to a longer lasting drawing surface in the die is another important result.

✦ ✦ ✦

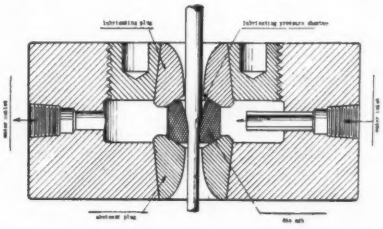
A MERELY casual thought about the structure of the Tungsten Carbide material will easily explain how effectual cooling of the dies is in prolonging the life of the material. In the sintering of Tungsten Carbide finely ground particles of tungsten carbide are surrounded by molten cobalt or other "binder" Consequently in the very process of manufacture of Tungsten Carbide the "binder" has a much lower melting point than the tungsten carbide. Any development of heat in the drawing process will first affect the cobalt. Even if the heat does not reach the melting point of cobalt, the cobalt will become plastic and then the tungsten carbide will very easily wear away, since it has lost its footing in the main body of the die. Air-cooling or water-cooling, preferably the latter, may be used to reduce much of the heat developed in the tungsten carbide die.

✦ ✦ ✦

YET even this cannot possibly draw the heat away fast enough. Since the nib must be securely held in a steel casing, to prevent breakage due to bursting strains, the heat must not only pass through the body of the nib but must also penetrate through the steel casing. Consequently the heat does not pass out quite as fast as might be desired. The closer the cooling agent comes to the drawing surface the quicker will be the transfer of heat away from the nib.

✦ ✦ ✦

THERE is now an ingenious device on the market which allows the nib itself to be cooled. The entire casing is eliminated. The reader will see by the accompanying drawing that water flows into the holder, swirls in a chamber and completely envelopes the tungsten carbide nib. The nib iteslf is supported at both ends by hardened plugs. The nib is lapped to a mastergage at both ends so that the nib and plugs are watertight (and one nib is interchangeable to any set of plugs). The top plug is tightened down firmly by means of the screw in which it is seated.



Incidentally this type of holder has been found to eliminate another fault of tungsten carbide dies. Many nibs fail to reach their guaranteed maximum size due to cracks perpendicular to the longitudinal axis of the nib. As may be seen the plugs will prevent such breakage. The plugs keep the nib in compression. The plugs also have a component of force in such a direction as will counteract any bursting stresses. After many exhaustive tests in various plants in the East, not one nib has failed because of breakage.

✦ ✦ ✦

ADVANTAGE is taken of this type of construction and the upper plug is converted to what is known as a "lubricating plug." It's

(*Please turn to page 348*)

INSULATOR?

Recently a manufacturer of insulating materials came to us with three samples of sheet insulation, each identical in material and processing but made up in three different colors. When samples were tested for insulating capacity on the new SE DIELECTRIC STRENGTH TEST SET two were good insulators but the third which was also about to be marketed as a high quality insulator actually proved to be a conductor of electricity. Why?

Experience has shown that minute quantities of impurities, overheating or faulty processing, even when best of raw materials are used, can result in low grade insulating products.

As in the above instance—even the use of the wrong coloring matter can render a really good insulating material worse than worthless for that purpose.

Obviously, therefore, there's need of constant check at various stages of production in order to maintain high standards of quality. To satisfy this need we have developed a group of instruments specially designed to insure maintenance of high quality standards in production of insulation materials and devices.

These instruments include Dielectric Strength Test Sets covering several ranges up to 30,000 volts, Insulation Resistance Meter and auxiliary apparatus for controlling humidity and temperature. We also design and build to order SPECIAL instruments to meet particular problems.

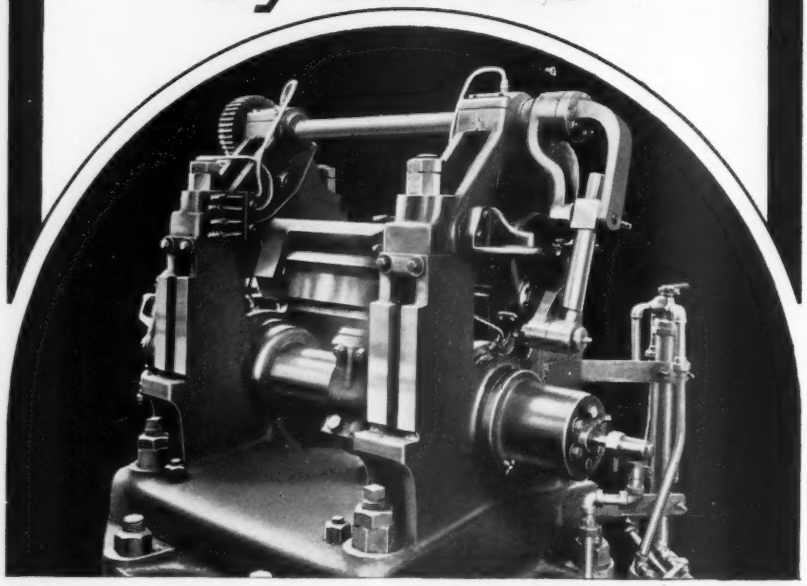
Illustrated above: Model 2-IE Dielectric Strength Test Set. Capacity 30,000 volts.

Learn more about these Insulation Testing Instruments—a new bulletin is available, sent on request. Our engineering staff may also be of assistance on other problems of production control, testing, and product development.

SOUND ENGINEERING CORPORATION

416 N. Leavitt Street
CHICAGO

FLYING SHEAR *by LEWIS*



FOR ROD MILLS, BAR MILLS AND STRIP MILLS

Either Steam, Air or Electrically Driven. We will be glad to send you complete data on this thoroughly modern and efficient shear.

LEWIS

LEWIS MAKES A COMPLETE LINE OF ROLLING MILL MACHINERY INCLUDING:

Mill drives up to and including 6,000 HP. Shape Straightener Machines up to and including 24 inch I beam. Motor operated Screw-Down for Mill. High Speed Gear Sets for Continuous Rod Mills. Continuous Bar and Billet Mills. Cold Mills for Sheet and Strip. Rail Breakers. Rail Re-Rolling Mills. Universal Mill Spindles. Chilled Iron and Iron Alloy Rolls for Iron, Steel, Brass, Copper, Aluminum, Zinc and Nickel. For hot Sheets, tin plate and strip—for cold sheets, tin plate and strip. For merchant bars and rods, Shears—Vertical Alligator—Cropping—Plate and Squaring. Special Machinery—Testing Machines and Iron and Steel Castings.

PITTSBURGH, PA.

LEWIS FOUNDRY & MACHINE CO.

Cooling Wire Dies

(*Continued from page 347*)

purpose is to guide the wire straight into the die and to wipe the lubricant into the pressure chamber in between itself and the die nib. The lubricant swept into this chamber develops a pressure forcing the lubricant through the die together with the wire.

✦ ✦ ✦

WIRE drawers can readily see that this improved method of die practice will reduce the cost of the die which the die manufacturer necessarily must charge due to the cost of the casing. When the die is finally worn out, it is thrown out and there is no loss of the casing.

✦ ✦ ✦

TESTS of this device have shown some surprising results. Bare nibs used in this type of type of holder have lasted in many cases twice as long as did Tungsten Carbide set in casings. In some cases the tonnage was tripled.

✦ ✦ ✦

WIRE drawers are devoting more and more of their energies toward improved die practice—not only to lower their die costs—but to improve the quality of their wire.

✦ ✦ ✦

New Monel Metal Booklet

A NEW booklet on the applications of Monel Metal, Nickel, and Nickel-clad steel has been issued by the Technical Service Department of The International Nickel Company. It has been prepared especially for users of industrial processing equipment.

✦ ✦ ✦

BESIDES giving data on the physical and mechanical properties of these materials, the booklet contains considerable miscellaneous information, including instructions on the selection of suitable welding rod and other details on fabrication. Copies will be supplied without charge on request to Editorial Department, The International Nickel Company, Inc.

Smelting, Casting and Rolling of Electrolytic Copper

(*Continued from page 329*)

which it is periodically cleaned out for recovery. Copper reclaimed in this way from the rolling pits and additional settling basins will amount to as much as .8% of the copper rolled.

✦ ✦ ✦

SCRAP occurs in all rolling operations which may amount to 1½ to 2%. This is most advantageously pressed by a ram into bundles weighing about 900 pounds and of the same dimensions as a stack of cathodes, so that it fits in with the charging operations at the Furnace Refinery, and presenting no undue amount of bulk, does not reduce the size of the furnace charge or interfere with the cycle of its operations.

✦ ✦ ✦

Reclaimation of Pickling Solution

A THIRD by-product from rod rolling which has to be considered is the pickling solution from cleaning the black rod. Cleaning a million pounds of black rods will put about 1800 pounds of copper into solution as copper sulphate. Where conveniently located to an electrolytic plant the copper and acid are readily re-claimed by that process. In some other mills electrolytic units are installed for this purpose alone and other plants use other means of precipitating and recovering their copper such as the scrap iron method.

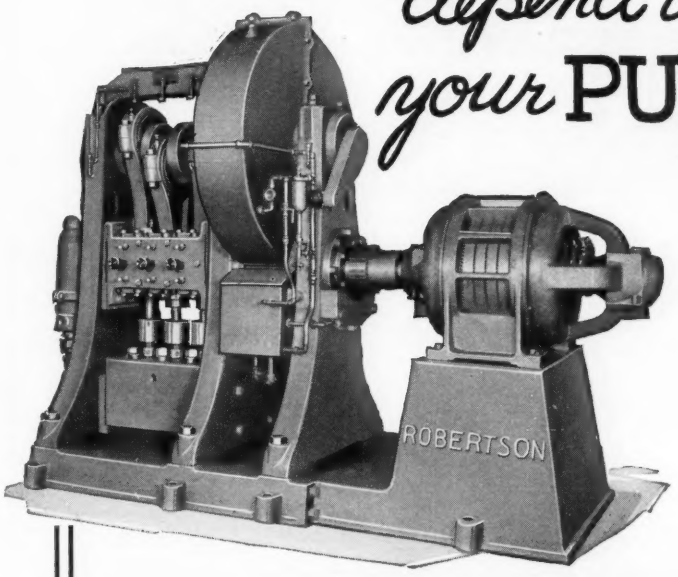
✦ ✦ ✦

Continuous Rolling Mills for Copper

FOLLOWING the steel mill practice where the bars are guided mechanically through the entire line of rolls, installations for copper have been built and these continuous rolling mills are now in operation. Good results have been reported regarding these installations; however, we are not personally familiar with the details of their accomplishments. The Belgian type mills with the mechanical handling of all the passes in the roughing mill and the square passes in the two small mills are successfully being used in several

(*Please turn to page 350*)

Your Extrusion Presses depend upon your PUMPS



After all's said and done, ANY EXTRUSION PRESS IS ONLY AS EFFECTIVE AS THE PRESSURE THAT OPERATES IT,—or, putting it another way, an Extrusion Press can't operate without the proper Hydraulic Pressure.

For best results High Pressure Hydraulic Pumps must be efficient and reliable. They must be accurately built, sturdy, rugged and low in operating and maintenance costs.

Robertson Pumps are built to meet these requirements. We invite comparison upon any basis. Robertson Pumps may cost a little more initially, but it's the "long haul" that counts.

Note: Robertson makes all types of lead-encasing machinery required by rubber hose and electrical cable makers: Extrusion Presses, Hydraulic Pumps, Melting Furnaces and Pots, Dies and Cores, also Lead Sheath Stripping Machines, and Hydro-pneumatic Accumulators.
Robertson lead encasing equipment is virtually a standard here and abroad, where in many cases it is used exclusively.

Are you receiving our little magazine, "Robertson Reminders"? If not, send us your name and address, and we'll gladly send it to you—regularly.

John ROBERTSON CO. INC. Pioneers-Since 1858

125-37 Water Street Brooklyn, N. Y.

RODINE
for
PICKLING

✦ ✦ ✦

RODINE, added to the pickling bath,
saves acid and metal,
and
lowers pickling costs.

Another advantage is perfectly pickled work. That's why progressive pickling departments use RODINE.

✦ ✦ ✦ *Send for Bulletin No. 15* ✦ ✦ ✦

American Chemical Paint Co.

AMBLER, PENNA.

General Offices and Factory

WE EXTEND OUR GREETINGS
TO THE MEMBERS OF
THE WIRE ASSOCIATION

✦◆✦

STEELSKIN

REG. U. S. PAT. OFFICE

For High or Low Carbon Wire

WIRE DRAWING SOAPS

Established 30 years.

R. H. MILLER CO., Inc. **Homer, N. Y.**

Corrosion and Hot Galvanizing of Iron and Steel

(*Continued from page 302*)

WHERE the coated article is to be deformed, the less pure grades of zinc are used; where bending properties are desired, however, it is preferable to use the grades carrying only small amounts of cadmium and lead.

✦ ✦ ✦

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(1) Rawdon: — "Protective Metallic Coatings" 1928.
(2) Chem. & Ind. (52) 10 P. 200 1933.
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(4) J. Chem. Soc. 125-604 (1924).
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✦ ✦ ✦

Smelting, Casting and Rolling

(*Continued from page 349*)

plants with perfectly satisfactory results, men still being employed to turn in the ends on the oval side. Contrary to what might be expected from operations as hazardous as hot rod rolling, accidents and burns to the employees can be kept very low. Safety guards and posts are installed wherever they can serve a good purpose. Ventilation is well taken care of in all mills in the way of ample exhaust fans for the removal of copper dust and man coolers installed at important points for circulating outside fresh air. The men are constantly cautioned as to unsafe practices and trained in first aid work. As a result of what can be accomplished, we have a record at the Great Falls plant of the Anaconda Wire and Cable Company of no lost time accident in the last 2½ years of operation of the rolling mills A lost time accident is one in which one day or more is lost on account of injury or burn.

✦ ✦ ✦

Quality In Final Product The Aim of All Questions

IT will be seen from the above discussion of the smelting,

casting and rolling of electrolytic copper, that quality of the final product has become the watchword, and that the producers are taking every precaution to supply the consumer with high grade wire rods which can be fabricated with the minimum amount of difficulty in their mills.

✦ ✦ ✦

(1) S. Skowronski. Oxygen & Sulphur in the Melting of Cathode Copper. Trans. A. I. M. E. (1918) 60-307.

(2) E. S. Bardwell. A Comparison of the Use of Various Fuels in Copper Refining Furnaces. Trans. A. I. M. E. (1932).

(3) S. Skowronski. Relation of Sulphur to the Overpoling of Copper. Trans. A. I. M. E. (1918) 60-312.

(4) O. W. Ellis. Gasses in a Sample of Overpoled Fire Refined Copper. Trans. A. I. M. E. (1929).

✦ ✦ ✦

Reel and Spool Standardization

THE Manufacturers' Committee on Spools and Reels has called a meeting of the Committee to be held at the Wire Association headquarters, Hotel New Yorker at 2:00 P. M., October 2nd, 1934 for the purpose of electing officers and such other matters that may be presented.

✦ ✦ ✦

AT this meeting complete description and drawings of the proposed new standard sizes of reels and spools will be presented for approval.

✦ ✦ ✦

ALL manufacturers interested in reel and spool standardization are invited to attend this meeting. Further information can be obtained from Frank Mossberg, President, Mossberg Pressed Steel Corp., Attleboro, Mass., President of the Manufacturers' Committee For Standardization of Reels and Spools.

✦ ✦ ✦

Make Your Plans Now
To Attend The
Wire Association
Meeting
At New York, Oct. 1-5, 1934

If You Are Using Sulphuric Acid . . .

Use equipment that is sulphuric acid proof.

"DURIRON" will handle sulphuric acid in all concentrations and at all temperatures. And it is available in pumps from 1" discharge to 8" discharge, valves, pipe and fittings, steam jets and numerous other standard items as well as in special castings.

FOR a machinable alloy, "Durimet", a nickel-chromium-silicon **low carbon** alloy steel is ideal for sulphuric acid under oxidizing conditions: for all concentrations at room temperature; for boiling, up to 15% concentration with or without oxidizing salts such as ferric sulphate.

Much standard equipment is made of Durimet besides castings made to order.

FOR sulphuric acid under non-oxidizing conditions, "Alcumite", a copper base aluminum iron alloy, is a most satisfactory machinable alloy. In it, too, are produced pumps, valves, pipe fittings, and other standard items including special castings and hot rolled rod.

WHEN it comes to Sulphuric Acid, come to The Duriron Company for something to handle it.

And for Muriatic Acid, "Durichlor" is equally satisfactory.

The Duriron Company, Inc.

442 N. Findlay St. Dayton, Ohio

INDISPENSABLE!

◆

THREE WIDELY USED OAK DRAWING LUBRICANTS

Super Draw No. 5
Master Draw No. K
For copper, brass and phosphor bronze.

Master Draw No. 2
For steel and alloy steel wire. Particularly adaptable to draw bench work.

Master Draw No. 425
For drawing bars and shapes, (high or low carbon) on draw benches, WITHOUT LIME COAT.

Proper drawing lubricants are as indispensable as the machines on which your products are drawn. Your lubricants should be fitted to local conditions and to the brass, bronze, steel or copper.

The Oak Chemical Products Company will be glad to assist you in the determination of the right lubricant. Your inquiry will receive prompt, careful attention without obligation to you. Write today!

◆

OAK CHEMICAL PRODUCTS COMPANY
Bechtelsville, Pa.

LUBRICANTS FOR COLD DRAWING ANY TYPE OF METAL

STANDARD OR SPECIAL DESIGN
MACHINES AND EQUIPMENT
FOR
WIRE, ROD OR STRIP MILL

Cold Rolling Equipment

Strip Coilers — Rod Coilers

Galvanizing and Tinning Equipment
Scrap Bundling Machines
Wire Drawing Machines—Continuous
and for Fine Wire

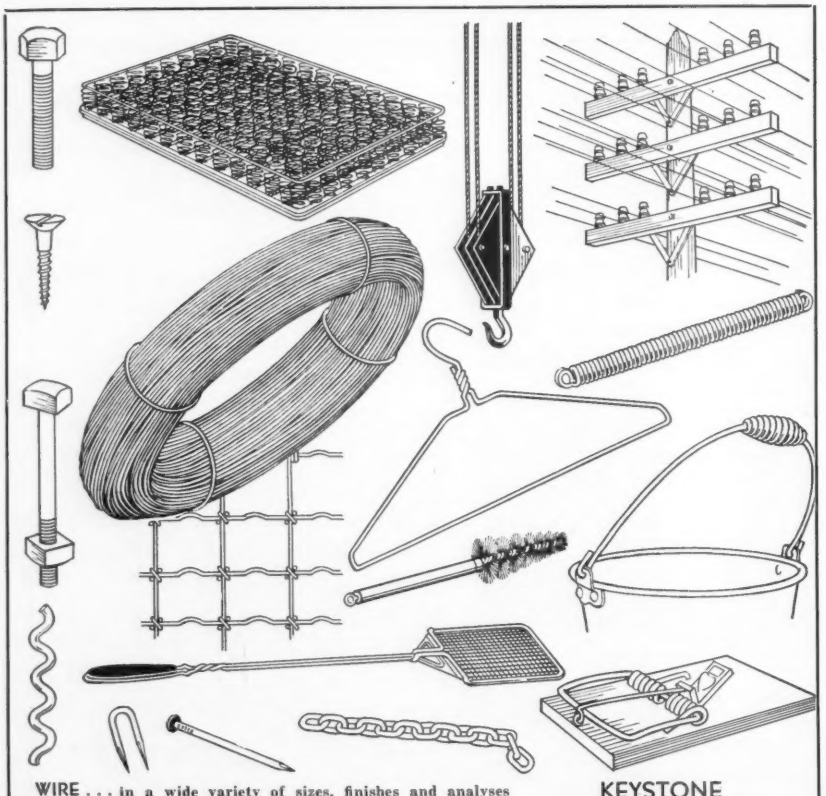
Cotter Pin, Edging, Straightening
and Cutting Machines.
Cleaning and Pickling Equipment

Pointers — Swadgers — Wire Frames

Wire Puller Tongs

High Grade Equipment at Present Day Prices
Your Inquiries Invited

BRODEN CONSTRUCTION CO.
ENGINEERS - BUILDERS
WIRE MILL AND COLD ROLLING EQUIPMENT
10255 HARVARD AVENUE
CLEVELAND



WIRE . . . in a wide variety of sizes, finishes and analyses for the manufacture of products that require a special wire. Your inquiry will receive the careful attention of an organization experienced in furnishing uniform high quality wire that improves your product and reduces its cost.

KEYSTONE
STEEL & WIRE CO.
PEORIA, ILL.

Recent Wire Patents

Complete Descriptions and Drawings of Patents May Be Had for 25 cents. Address, Wire & Wire Products, 17 East 42nd St., New York.

No. 1,961,991, PROCESS OF MAKING ELECTRICALLY WELDED WIRE MESH MATERIAL, Patented June 5, 1934 by Raymond J. Southwell, New Rochelle, N. Y., assignor to Welded Fabrics Corporation, New York, N. Y., a corporation of New York.

The weft wire material is laid upon the warp wires in continuous length, being looped in bights at the ends of the fabric, the crossing being then welded.

✦ ✦ ✦

No. 1,962,436, SPRING ASSEMBLY UNIT, Patented June 12, 1934 by Clare T. Dyer, Holland, Mich., assignor to Charles Karr Company, a corporation of Michigan.

Springs are provided for supporting one or more of the marginal edges of the spring assembly together.

✦ ✦ ✦

No. 1,962,885, BED SPRING, Patented June 12, 1934 by Arthur Wesley, Chicago, Ill., assignor to Burton-Dixie Corporation, Chicago, Ill., a corporation of Delaware.

The novelty in this bed spring lies in a plurality of flat metal strips interwoven with the top terminal coils of the spiral springs.

✦ ✦ ✦

No. 1,963,015, SPRING-CUSHION, Patented June 12, 1934 by Oliver M. Burton, Chicago, Ill., assignor to Burton-Dixie Corporation, Chicago, Ill., a corporation of Delaware.

This inventor provides a sheet of woven wire fabric disposed over the ends of the spiral springs, to which the latter are connected.

✦ ✦ ✦

No. 1,963,033, SCREW CUTTING MACHINE, Patented June 12, 1934 by Harry W. Ruppel, Shaker Heights, Ohio, assignor to The Cleveland Automatic Machine Company, Cleveland, Ohio, a corporation of Ohio.

In a screw cutting machine, the inventor provides an apparatus for effecting the reciprocation of a tool slide having a rotatably driven cutting tool mounted thereon.

✦ ✦ ✦

No. 1,964,988, NAIL MACHINE, Patented July 3, 1934 by Charles K. Hill, Cleveland, Ohio.

More particularly, this machine is provided for manufacturing drive screws from twisted wire.

✦ ✦ ✦

No. 1,966,929, WOVEN WIRE TUBE, Patented July 17, 1934 by Edgar E. Kellems, New York, N. Y., assignor to Kellems Products, Inc., New York, N. Y., a corporation of New York.

A tapered cable grip is provided by this inventor.

Canadian Copper From The Mine To The Wire User

(*Continued from page 320*)

CANADA'S future success in the mining and copper conversion lies in low overhead and capitalization, the extent to which the ore is processed after being mined and the quality and quantity of other valuable minerals as a by-product.

✦ ✦ ✦

How To Select Insulated Cable

A NEW 80-page reference book on "How to Select Insulated Cable" has been published by the General Electric Company. Designated as GEA-1837, the publication covers cable for the transmission and distribution of electric power at normal frequencies, and presents in convenient form the information that is required in determining the cable best adapted for a particular installation.

✦ ✦ ✦

THE more usual applications of cable are covered. The subject of cable economics, not properly within the scope of this book, is touched on only lightly to insure that an economic decision will not be based on the price of the cable alone, to the exclusion of other important factors.

✦ ✦ ✦

TWO methods of selecting conductor size are given. The first, a comparatively simple one, covers cable for wiring houses, buildings, small industrial plants, and similar applications. The other method, more detailed, includes 27 tables of current-carrying capacities.

✦ ✦ ✦

THE various types of insulation and finish are described, and tables of thickness are given. Tables of wire gauges and dimensions, sizes of shipping reels, and a bibliography are also included.

✦ ✦ ✦

THE book should be useful to cable engineers, electrical engineers of industrial plants, consulting engineers, architects, contractors, and college professors.

"JENNY" INSULATING MACHINES

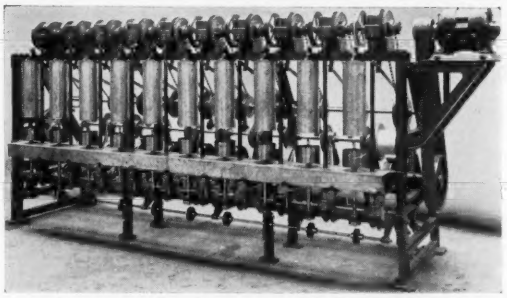
For Cotton, Silk And Paper Wrapping

10 A-20 A For Single Covering

✦ ✦ ✦

10 B-20 B For Double Covering

✦ ✦ ✦



Range of Sizes No. 6 to No. 40 B & S Gauge

✦ ✦ ✦

These machines are built in units of 10 and 20 spindles

✦ ✦ ✦

These machines operate at a flier speed of 4000 to 7500 R. P. M. according to material used.

✦ ✦ ✦

R. HARRY JENNY

Manufacturer of

INSULATING MACHINES and APPLIANCES

"An Engineering Service to the Wire Trade"

P. O. Box 668 New Haven, Conn.

APCO HIGH SPEED BRAIDER CARRIERS

THIS new Braider Carrier is destined to be universally adopted wherever increased output and a higher grade of finished work is desired at a lower cost of production.

WE are prepared to demonstrate that these carriers will increase your output over your present equipment.

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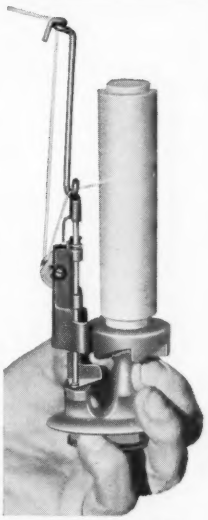

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✦ ✦ ✦

THIS manual covers the procedure to be followed for case hardening, reheating, nitriding and mottling steels with du Pont sodium cyanide. It also describes the procedure for coloring, tempering and drawing steels with du Pont heat treating salts.

✦ ✦ ✦

TYPICAL of the scope of the manual is the section devoted to discussion of the influence of time of immersion, temperature, composition of the bath and the type of steel on the composition and depth of the case obtained with cyanide. The illustrations, made from microphotographs, show the effects of temperature in the composition of the case. Other subjects are as thoroughly discussed.

✦ ✦ ✦

METHODS of analysis of mixtures, heat treating tables and other data add to the value of the manual as a contribution to the art of heat treating steels.

✦ ✦ ✦

THE manual contains twenty-eight pages and is bound in a sturdy paper cover. It has been prepared in 8½ x 11 size, suitable for cabinet filing, and is also punched to adapt it to notebook filing.

BECAUSE of the number of papers printed in this issue of WIRE AND WIRE PRODUCTS as preprints for The Wire Association Meeting the departments relating to "Exports and Imports" and "News of the Industry" have been omitted.

These departments will be published in full in the October issue including the matter omitted.

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Lubrication For Copper Wire

(*Continued from page 339*)

production was very low, he was quite sure that the rod was bad or that the die man was getting careless. If the boss, in checking up, failed to substantiate these alibis, he could always resort to the excuse that the night turn had ruined his "dope", and this one no man but himself could disprove.

✦ ✦ ✦

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TODAY, the modern mill receives its lubricant with the kinks ironed out, in a tamper-proof, hermetically sealed steel barrel. Only clean materials enter into its manufacture, and the whole is treated with a germicide to guard against any possibilities of rancidity or infection.

✦ ✦ ✦

WHEN ready for use, water only is added to it, and the proportion is not critical—"cut and try" fussing with the lubricant is done away with, and the cost of the compound is only a fraction of that of the old-time "dope".

✦ ✦ ✦

IF correct lubrication is used in conjunction with the wonderfully efficient modern machine and die, no great amount of skill on the part of the operator is necessary to obtain steady, consistent production at high rates of speed, even though other contributing factors are not entirely perfect.

✦ ✦ ✦

Selection of Proper Lubricant Is of Major Importance

BUT if the lubricant is wrong—everything will be wrong. Oftimes the quality of the rod, the shape of the die, the strength of the weld, or the efficiency of the machine itself is erroneously blamed for trouble, delay and loss of production, which is primarily due to faulty lubrication.

✦ ✦ ✦

THEREFORE, it is a matter of major importance to production that a lubricant of known value and dependability be used. Such a lubricant, in order to insure compounded in sizable quantities, under laboratory control, and by means of adequate compounding equipment. When so obtained, the most troublesome "variable" in wire mill practice is definitely eliminated.

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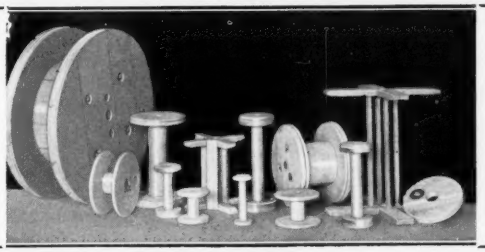

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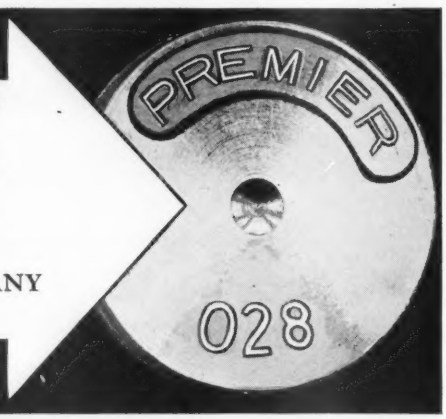

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The National Metal Congress and Exposition

THE first National Metal Congress and Exposition ever held in New York City will be the greatest since the one in Cleveland in 1929, according to the statement from W. H. Eisenman, secretary of the American Soicety for Metals and director of the Exposition.

✦ ✦ ✦

OCTOBER 1-5, 1934 is the date. The Exposition will be held in the Port Authority Building at 14th and 8th avenues, and the sessions of the Congress will be held there and in Hotels Pennsylvania and New Yorker.

✦ ✦ ✦

ALREADY the show itself is 30% larger than last year's, and the technical programs of the five societies cooperating in the National Metal Congress are even larger and more varied in scope than usual.

✦ ✦ ✦

MEMBERS of the American Society for Metals, the Institute of Metals and Iron and Steel Divisions of the A. I. M. E. and the Iron and Steel Division of the A. S. M. E. will have headquarters at Hotel Pennsylvania. The New Yorker will be meeting place of the American Welding Society and the Wire Association.

✦ ✦ ✦

Detroit Warehouse for Steel Sale Corporation

EVIDENCE of returning improved conditions take form in the recent opening of a large metal distributing warehouse in Detroit, by the Steel Sales Corporation of Chicago. Increase of steady employment is insured by the type of expansion experienced by this company who have previously maintained only a sales office in Detroit.

✦ ✦ ✦

THE service to the manufacturer is somewhat broader than is indicated by the name of this warehousing concern, which has grown from a distributor of steel to that of a number of non-ferrous metals and includes all grades of finished steel in bars, strips, sheets, tubes, wire and welding rods and all non-ferrous metals

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Sleeper & Hartley, Inc., Worcester, Mass.

MACHINERY—Staple
Sleeper & Hartley, Inc., Worcester, Mass.

MACHINERY—Straightening
Broden Construction Co., Cleveland, O.
Hallden Machine Co., Thomaston, Conn.
H. J. Ruesch Machine Co., Newark, N. J.
F. B. Shuster, New Haven, Conn.
Sleeper & Hartley, Inc., Worcester, Mass.

MACHINERY—Stranding
New England Butt Co., Providence, R. I.
Sleeper & Hartley, Inc., Worcester, Mass.
Thomson-Judd Wire Machinery Co., Lynn, Mass.
Watson Machine Co., Paterson, N. J.

MACHINERY—Strip Steel
Broden Const. Co., Cleveland, O.
Lewis F'dry & Machine Co., Pittsburgh, Pa.
H. J. Ruesch Machine Co., Newark, N. J.

MACHINERY—Swaging
H. J. Ruesch Machine Co., Newark, N. J.
Sleeper & Hartley, Worcester, Mass.
Waterbury Farrel Foundry & Machine Co., Waterbury, Conn.

MACHINERY—Taping
Amer. Insulating Mach. Co., Phila., Pa.
New England Butt Co., Providence, R. I.
Thomson-Judd Wire Machinery Co., Lynn, Mass.
Watson Machine Co., Paterson, N. J.

MACHINERY—Tinsel Rolling Mills
Amer. Insulating Mach'y Co., Phila., Pa.

MACHINERY—Trolley Wire
Vaughn Machinery Co., Cuyahoga Falls, O.

MACHINERY—Tube Mill
H. J. Ruesch Machine Co., Newark, N. J.

MACHINERY—Welding Wire
Micro Products Co., Chicago, Ill.
F. B. Shuster Co., New Haven, Conn.
Thomson-Judd Wire Machinery Co., Lynn, Mass.

MACHINERY—Winding
American Insulating Mach'y Co., Phila., Pa.
New England Butt Co., Providence, R. I.
Sleeper & Hartley, Inc., Worcester, Mass.
Watson Machine Co., Paterson, N. J.

MACHINERY—Wire Drawing
American Insulating Machinery Co., Phila.
Broden Const. Co., Cleveland, Ohio.
Morgan Construction Co., Worcester, Mass.
H. J. Ruesch Machine Co., Newark, N. J.
E. J. Scudder Foundry & Machine Co., Trenton, N. J.
Sleeper & Hartley, Inc., Worcester, Mass.
Thomson-Judd Wire Machinery Co., Lynn, Mass.
Vaughn Machinery Co., Cuyahoga Falls, O.
Waterbury Farrel Foundry & Machine Co., Waterbury, Conn.

MACHINERY—Wire Rope
New England Butt Co., Providence, R. I.
Thomson-Judd Wire Machinery Co., Lynn, Mass.
Watson Machine Company, Paterson, N. J.

MACHINERY—Wire Tinning
American Insulating Mach'y Co., Phila., Pa.

PAPER—Insulating
E. W. Twitchell, Inc., Phila., Pa.

PICKLING COMPOUNDS—
American Chemical Paint Co., Ambler, Pa.
Delany Chemical Co., Tacony Station, Philadelphia, Pa.
Grasselli Chemical Co., Cleveland, O.
Wm. M. Parkin & Co., Pittsburgh, Pa.

PICKLING TANK LININGS
Ceilcote Company, The, Cleveland, O.

POTS—Lead Melting
John Robertson Co., Brooklyn, N. Y.

PRESSES—Hydraulic & Mechanical
Farrel-Birmingham Co., Inc., Ansonia, Conn.
John Robertson Co., Brooklyn, N .Y.

PRESSES—Lead Encasing
John Robertson Co., Brooklyn, N. Y.

PRESSES—Lead Extrusion
John Robertson Co., Brooklyn, N. Y.

PULLERS—Wire
E. J. Scudder Fdry. & Machine Co., Trenton, N. J.
Sleeper & Hartley, Inc., Worcester, Mass.

PUMPS—Hydraulic
John Robertson Co., Brooklyn, N. Y.

REELS AND SPOOLS—All Kinds
American Pulley Co., Philadelphia, Pa.
Apco Mossberg Corp., Attleboro, Mass.
Avoca Mfg. Co., Avoca, N. Y.
Hubbard Spool Company, Chicago, Ill.
Mossberg Pressed Steel Corp., Attleboro, Mass.

REEL AND TENSION STAND—
Sleeper & Hartley, Inc., Worcester, Mass.

REEL CRUTCHES
Watson Machine Co., Paterson, N. J.

RODS—Wire—Non Ferrous
American Brass Co., Waterbury, Conn.
Hudson Wire Co., Ossining, N. Y.
Platt Bros. & Co., The, Waterbury, Conn.
Seymour Mfg. Co., Seymour, Conn.

RODS—Wire—Steel
Keystone Steel & Wire Co., Peoria, Ill.
Republic Steel Company, Youngstown, O.
Youngstown Sheet & Tube Co., Youngstown, O.

ROLLING MILLS—See Machinery—Rolling Mill

ROLLS—
Farrel-Birmingham Co., Inc., Ansonia, Conn.
Lewis F'dry & Machine Co., Pittsburgh, Pa.

RUST PROOF COMPOUND
American Lanolin Co., Lawrence, Mass.
Hanson-Van Winkle-Munning, Matawan, N. J.

SOAPS—Wire Drawing
Ironsides Company, Inc., The, Columbubs, O.
R. H. Miller Co., Homer, N. Y.
Oak Chemical Co., Bechteisville, Pa.

SPOOLS
American Pulley Co., Philadelphia, Pa.
Apco Mossberg Corp., Attleboro, Mass.
Avoca Mfg. Co., Avoca, N. Y.
Hubbard Spool Company, Chicago, Ill.
Mossberg Pressed Steel Corp., Attleboro, Mass.

STRIP—Brass, Zinc and Non Ferrous
American Brass Company, Waterbury, Conn.
Hudson Wire Company, Ossining, N. Y.
Platt Bros. & Co., The, Waterbury, Conn.
Seymour Mfg. Co., Seymour, Conn.

BUYERS' GUIDE, Continued

STRIP—Steel
Republic Steel Corp., Youngstown, O.
Youngstown Sheet & Tube Co., Youngstown, O.

TANKS—Compound
Watson Machine Co., Paterson, N. J.

TESTING INSTRUMENTS—Dielectric
Sound Engineering Co., Chicago, Ill.

TRUCKS
Morgan Construction Co., Worcester, Mass.
Vaughn Machinery Co., Cuyahoga Falls, O.

TUBE BENDERS AND FORMERS
H. J. Ruesch Machine Co., Newark, N. J.

TUMBLING BARRELS
Hanson-VanWinkle-Munning, Matawan, N.J.

VALVES AND FITTINGS—Acid-Proof
Duriron Co., The, Dayton, O.

VULCANIZERS
John Royle & Sons, Paterson, N. J.
Watson Machine Co., Paterson, N. J.

VULCANIZING PANS
American Insulating Mach'y Co., Phila., Pa.

WIRE—Electric
American Brass Company, Waterbury, Conn.
Hudson Wire Co., Ossining, N. Y.

WIRE—Enameled For Coils
Winsted Division of Hudson Wire Co., Winsted, Conn.

WIRE—Manufacturers
Keystone Steel & Wire Co., Peoria, Ill.
Republic Steel Corp., Youngstown, O.
Youngstown Sheet & Tube Co., Youngstown, O.

WIRE—Nickel Silver and Phosphor Bronze
American Brass Co., Waterbury, Conn.
Hudson Wire Company, Ossining, N. Y.
Seymour Mfg. Co., Seymour, Conn.

WIRE—Non Ferrous to Specification For Special Purposes
American Brass Company, Waterbury, Conn.
Hudson Wire Company, Ossining, N. Y.
Seymour Mfg. Co., Seymour, Conn.
Winsted, Div. of Hudson Wire Co., Winsted, Conn.

WIRE—Spring
American Brass Co., Waterbury, Conn.
Keystone Steel and Wire Co., Peoria, Ill.
Republic Steel Corp., Youngstown, O.
Seymour Mfg. Co., Seymour, Conn.
Youngstown Sheet & Tube Co., Youngstown, O.

WIRE—Steel—Also Coppered Steel—Also Galvanized Steel
Keystone Steel & Wire Co., Peoria, Ill.
Republic Steel Corp., Youngstown, O.
Youngstown Sheet & Tube Co., Youngstown, O.

WIRE—Weaving, Non Ferrous
American Brass Co., Waterbury, Conn.

WIRE AND STRIP—Brass, Zinc
American Brass Co., Waterbury, Conn.
Platt Bros. & Co., The, Waterbury, Conn.

This is a carefully classified index of concerns who specialize in this industry and who advertise regularly in WIRE & WIRE PRODUCTS. Please mention WIRE when writing to these firms.

1934
Annual Meeting
of the
Wire Association
Will be held at New York, N. Y.
OCTOBER 1-5 INCLUSIVE
in association with the
National Metal Congress

Wire Association Headquarters at Hotel New Yorker

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General Castings for Wire Mill use.
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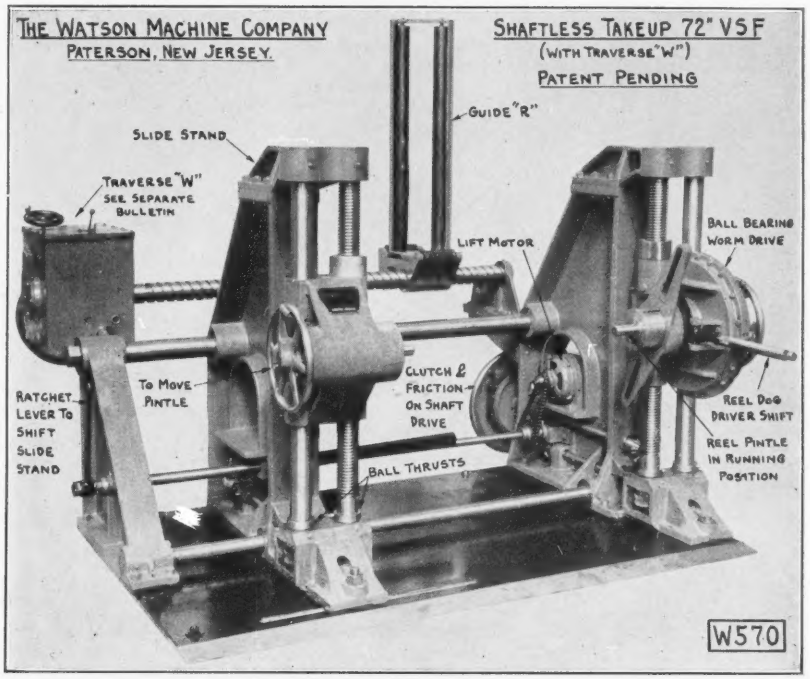
PATERSON, NEW JERSEY, U. S. A.

ENGINEERS - FOUNDERS - MACHINISTS

SHAFTLESS TAKEUPS TYPE "V"

For Heavy Duty
(Patent Pending)



THE MOST IMPORTANT SINGLE POINT OF THIS TYPE THE ELIMINATION OF THE REEL SHAFT.

The elimination of minor injuries to operator in handling large reel shafts is also a point of considerable value.

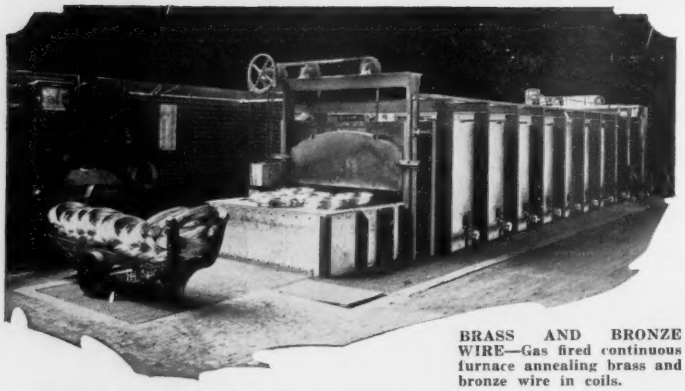
Two sizes are built—

72″ for loads up to 6 tons (picking up 36″ or larger reels from base).

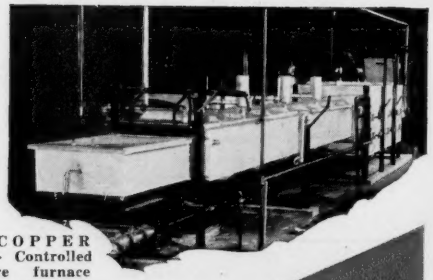
96″ for loads up to 10 tons (picking up 48″ or larger reels from base).

The multiple disc slip-friction is adjustable in operation and this, with the slack takeup handwheel combined with positive clutch, centers drive control at the stand in a convenient position.

ELECTRICAL WIRE AND CABLE
WIRE ROPE and CORDAGE MACHINERY



BRASS AND BRONZE WIRE—Gas fired continuous furnace annealing brass and bronze wire in coils.



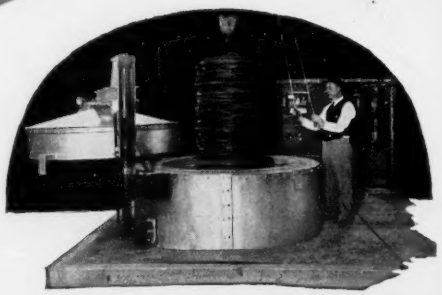
FINE COPPER WIRE — Controlled atmosphere furnace br ght annealing fine copper wire on spools —continuously.

SCALE FREE HARDENING—Controlled atmosphere furnaces of the continuous type shown for treating bolts, etc.

Fuel Fired And Electric Furnaces For The Wire Industry

Designed and Built by

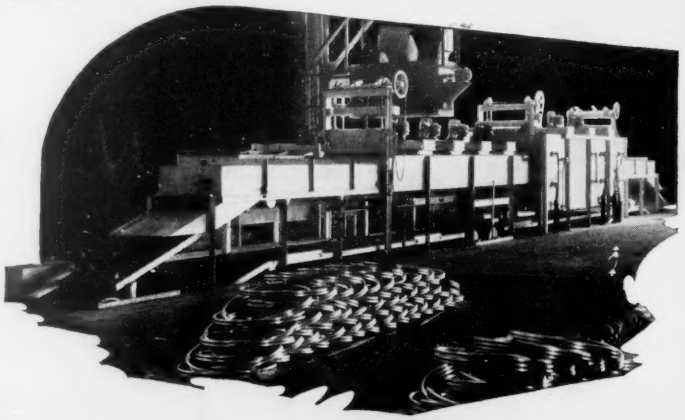
The Electric Furnace Co., Salem, Ohio



ALLOY WIRE ROD—Pit type furnace annealing alloy wire rod in coils without scale or decarburization.

LOW CARBON STEEL WIRE—New fuel-fired, pit type, wire annealing furnaces—have shown improved fuel economy, more uniform anneal and decreased annealing time.

BRIGHT ANNEALING—Continuous, controlled atmosphere furnaces designed and built for bright annealing ferrous and non-ferrous products.



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SALEM, OHIO.

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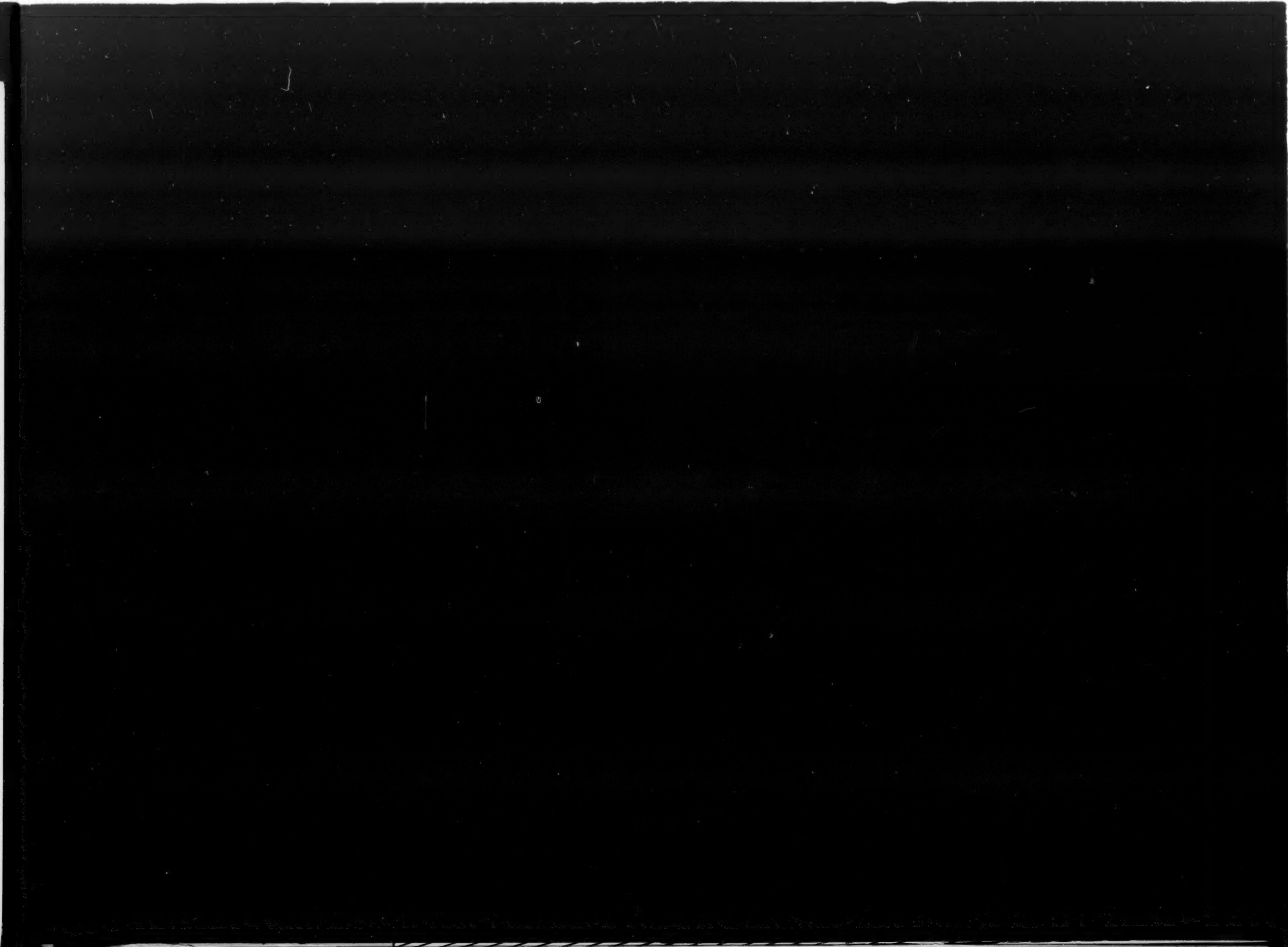
ELECTRIC FURNACES